Hardware Service Manual

Allen-Bradley

PowerFlex Active Front End—Frame 13

PowerFlex AFE / PowerFlex 700AFE
(400/480V and 600/690V)

Allen-Bradley • Rockwell Software

Rockwell Automation

Important User Information

Read this document and the documents listed in the additional resources section about installation, configuration, and operation of this equipment before you install, configure, operate, or maintain this product. Users are required to familiarize themselves with installation and wiring instructions in addition to requirements of all applicable codes, laws, and standards.

Activities including installation, adjustments, putting into service, use, assembly, disassembly, and maintenance are required to be carried out by suitably trained personnel in accordance with applicable code of practice.

If this equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

In no event will Rockwell Automation, Inc. be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment.

The examples and diagrams in this manual are included solely for illustrative purposes. Because of the many variables and requirements associated with any particular installation, Rockwell Automation, Inc. cannot assume responsibility or liability for actual use based on the examples and diagrams.

No patent liability is assumed by Rockwell Automation, Inc. with respect to use of information, circuits, equipment, or software described in this manual.

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Throughout this manual, when necessary, we use notes to make you aware of safety considerations.

	WARNING: Identifies information about practices or circumstances that can cause an explosion in a hazardous environment, which may lead to personal injury or death, property damage, or economic loss.
	ATTENTION: Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss. Attentions help you identify a hazard, avoid a hazard, and recognize the consequence.
IMPORTANT	Identifies information that is critical for successful application and understanding of the product.

Labels may also be on or inside the equipment to provide specific precautions.

	SHOCK HAZARD: Labels may be on or inside the equipment, for example, a drive or motor, to alert people that dangerous voltage may be present.
	BURN HAZARD: Labels may be on or inside the equipment, for example, a drive or motor, to alert people that surfaces may reach dangerous temperatures.
	ARC FLASH HAZARD: Labels may be on or inside the equipment, for example, a motor control center, to alert people to potential Arc Flash. Arc Flash will cause severe injury or death. Wear proper Personal Protective Equipment (PPE). Follow ALL Regulatory requirements for safe work practices and for Personal Protective Equipment (PPE).

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The information below summarizes the changes to this manual since its last release (January 2010).

Change	Page
Added information for Frame 13 AFE in IP20 2500 MCC Style enclosure.	Throughout manual
In Chapter 1, revised faults table information.	1-2…1-7
Added new Chapter 2 ‘Active Front End System Overview’.	2-1
Old Chapter 2 is now new Chapter 3 ‘Component Test Procedures’.	3-1
Old Chapter 3 is now new Chapter 4 ‘AFE Power Structure Component Section’. Reorganized the following Power Structure Access Procedures subsections: • Subsection ‘Removing/Installing AFE Protective Barriers’ is now first. • Subsection ‘Removing/Installing the Air Flow Plate’ is now second. • Subsection ‘Removing/Installing Protective Covers…’ is now third.	 4-10 4-12 4-13
Added new Chapter 5 ‘AC Line Switchgear Component Section’.	5-1
Added new Chapter 6 ‘Precharge Component Section’.	6-1
Added new Chapter 7 ‘LCL Filter Component Section’.	7-1
Added new Chapter 8 ‘DC Fuses Component Section’.	8-1
Old Chapter 4 is now new Chapter 9 ‘Startup After Repair’.	9-1
In Appendix B: • Added Frame 13 Control Wiring Diagram for AFE in IP20 2500 MCC Style enclosure. • Added Frame 13 Control Wiring Diagram for AFE in IP21 Rittal enclosure. • Added all system schematics for Frame 13 AFE in IP20 2500 MCC Style enclosure.	 B-6 B-15 B-8…B-14
In Appendix C, added new information and drawings.	Appendix C
In Appendix D: • Added ‘LCL Filter Assembly’ section. • Added ‘Precharge Assembly’ section. • Added ‘AC Line Switchgear’ section.	 D-5 D-7 D-9
Added new Appendix E ‘AFE Power One-line System Application Data’.	E-1

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Overview

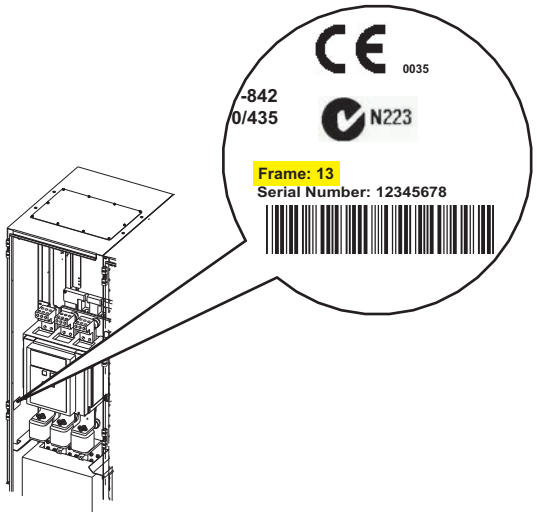
Who Should Use this Manual?

This manual is intended for qualified service personnel responsible for troubleshooting and repairing the PowerFlex® Active Front End (AFE). You should have previous experience with, and basic understanding of, electrical terminology, procedures, required troubleshooting equipment, equipment protection procedures and methods, and safety precautions. See safety related practices contained in Standard for Electrical Safety in the Work Place, publication NFPA 70E.

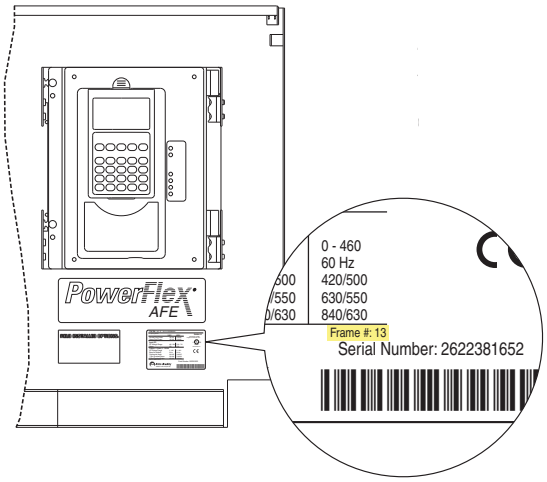
What is in this Manual

This manual contains hardware service information for the Frame 13 PowerFlex Active Front End. Verify that you are working on a Frame 13 by checking the data nameplate on the AFE. The frame number is printed just above the serial number.

Data Nameplate on AFE
in IP20 2500 MCC Style Enclosure



Data Nameplate on AFE
in IP21 Rittal Enclosure



What is Not in this Manual

This manual does not contain installation, start-up, and programming information. This information is available in the PowerFlex Active Front End User Manual, publication 20Y-UM001.

Additional Resources

You can view or download publications at http://www.rockwellautomation.com/literature. To order paper copies of technical documentation, contact your local Rockwell Automation distributor or sales representative.

General Information

The following publications provide general drive information.

Title	Publication
Wiring and Grounding Guidelines for Pulse Width Modulated (PWM) AC Drives	DRIVES-IN001
Safety Guidelines for the Application, Installation and Maintenance of Solid State Control	SGI-1.1
A Global Reference Guide for Reading Schematic Diagrams	100-2.10
Guarding Against Electrostatic Damage	8000-4.5.2

PowerFlex Active Front End Information

The following publications provide specific AFE information.

Title	Publication
PowerFlex Active Front End User Manual	20Y-UM001
PowerFlex 700H, 700S, and 700AFE Drive Fan Systems Installation Instructions	PFLEX-IN029
Drives in Common Bus Configurations Application Guidelines	DRIVES-AT002

For spare parts information for PowerFlex 7-Class Architecture Class Low Voltage AC Drives, including the PowerFlex Active Front End, go online at http://www.ab.com/support/abdrives/powerflex70/PF7ReleasedParts.pdf.

Understanding Manual Conventions

Become familiar with the following conventions used in this manual.

Terms

The following words are used throughout the manual to describe an action.

Word	Meaning
Can	Possible, able to do something
Cannot	Not possible, not able to do something
May	Permitted, allowed
Must	Unavoidable, you must do this
Shall	Required and necessary
Should	Recommended
Should Not	Not recommended

Cross References

‘Figure 3.1 on page 3-4’ is a cross reference to Figure 3.1 on page 4 of Chapter 3.

‘Figure C.1 on page C-3’ is a cross reference to Figure C.1 on page 3 of Appendix C.

Additional Support Available on Internet

Additional troubleshooting information and software tools are available on the Allen-Bradley Drives Technical Support website at http://www.ab.com/support/abdrives.

General Precautions for Class 1 LED Product

ATTENTION: Hazard of permanent eye damage exists when using optical transmission equipment. This product emits intense light and invisible radiation. Do not look into module ports or fiber optic cable connectors.

ATTENTION: The sheet metal cover and mounting screws on the ASIC Board located on the power structure are energized at (-) DC bus potential high voltage. Risk of electrical shock, injury, or death exists if someone comes into contact with the assembly.

ATTENTION: To avoid an electric shock hazard, verify that the voltage on the bus capacitors has discharged completely before servicing. Check the DC bus voltage between the +DC and -DC terminals, between the +DC terminal and the chassis, and between the -DC terminal and the chassis. The voltage must be zero for all three measurements.

ATTENTION: Potentially fatal voltages can result from improper usage of an oscilloscope and other test equipment. The oscilloscope chassis can be at a potentially fatal voltage if not properly grounded. Use high voltage differential voltage probes for all voltage measurements with the oscilloscope chassis correctly grounded to an earth ground.

ATTENTION: The PowerFlex Active Front End contains electrostatic discharge (ESD) sensitive parts and assemblies that can be damaged if you do not follow ESD control procedures. Static control precautions are required to install, test, service, or repair this unit. If you are unfamiliar with static control procedures, see Guarding Against Electrostatic Damage, publication 8000-4.5.2, or any other applicable ESD protection handbook.

ATTENTION: An incorrectly applied or installed PowerFlex Active Front End can result in component damage or a reduction in product life. Wiring or application errors, such as, undersizing the motor, incorrect or inadequate AC supply, or excessive ambient temperatures can result in malfunction of the system.

ATTENTION: Only qualified personnel familiar with adjustable frequency AC drives and associated machinery should plan or implement the installation, start-up, and subsequent maintenance of the system. Failure to comply may result in personal injury and/or equipment damage.

Notes:

Troubleshooting and Error Codes

ATTENTION: To avoid an electric shock hazard, verify that all power to the PowerFlex Active Front End has been removed before performing any servicing or repairs.

ATTENTION: To avoid an electric shock hazard, verify that the voltage on the bus capacitors has discharged completely before servicing. Check the DC bus voltage between the +DC and -DC terminals, between the +DC terminal and the chassis, and between the -DC terminal and the chassis. The voltage must be zero for all three measurements.

ATTENTION: **Hot** surfaces can cause severe burns. **Do not** touch the heatsink surface during operation of the PowerFlex Active Front End. After disconnecting power allow time for cooling.

ATTENTION: The PowerFlex Active Front End contains electrostatic discharge (ESD) sensitive parts and assemblies that can be damaged if you do not follow ESD control procedures. Static control precautions are required to install, test, service, or repair this assembly. If you are unfamiliar with static control procedures, see Guarding Against Electrostatic Damage, publication 8000-4.5.2, or any other applicable ESD protection handbook.

Creating Fault Reports

Complete fault reports are critical for analysis and repair of modules returned to the factory.

At a minimum, do the following:

- Using an Allen-Bradley drive configuration tool such as Connected Components Workbench™ software, DriveExplorer™ software, or DriveExecutive™ software, do the following:
  - Upload all parameters from the PowerFlex Active Front End.
  - Run the Technical Support Wizard.
- Collect the AFE system application data shown in Appendix E.
- If possible, record the contents of the fault queue (faults and times of occurrence).
- Make record of the following:
  - Any burn marks on the rectifying module, DC capacitors, inverter bridge, charging resistors, balancing/precharging resistors, printed circuit boards, bus bars, cabling, and fiber optic cabling.
  - Any liquid and condensation marks on printed circuit boards, components, and mechanical parts.
  - Amount of dust and other additional particles on drive and drive components.
  - Any mechanical damage to the drive and drive components.
- Record the size and type of main fuses.
- Record any other important marks and damage.
- Note grounding type (solid, high resistance, or floating) and source impedance of the power distribution system.

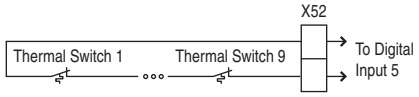
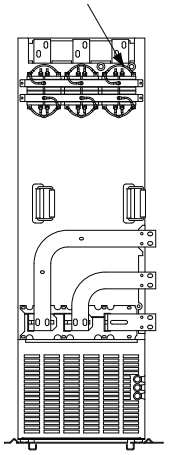
Addressing PowerFlex Active Front End Faults

No.	Name	Description	Action *(if appropriate)*
1	PrechargeActv	The AFE is still in precharge, because the charging switch (K20, K6, and K1 for AFE in IP20 2500 MCC Style enclosure or K20, K6, and Q1 for AFE in IP21 Rittal enclosure) is open. • faulty operation • component failure	Reset the fault and restart. Should the fault re-occur, contact Technical Support.
2	Auxiliary In	The AFE control digital input interlock is open.	Verify wiring to the digital inputs on the AFE control board are correct.
4	DC UnderVolt	The DC bus voltage fell below the minimum value of 333V for 400/480V units, or 461V for 600/690V units. You can enable/disable this fault with parameter 120 [Fault Config].	Monitor the incoming AC line for low voltage or power interruption.

No.	Name	Description	Action *(if appropriate)*
5	DC OverVolt	The DC bus voltage exceeded the maximum value of 911V for 400/480V units, or 1200V for 600/690V units.	1. Check if the AFE was in a regenerative current limit condition, which may indicate an excess regenerative load. 2. Adjust parameter 076 [Regen Power Lmt]. 3. Monitor incoming AC line for high voltage or voltage transients.
7	Overload	When input current exceeds 125% for 60 seconds or 150% for 30 seconds. The overload is a linear type in counting up.	Reduce the current consumption of the AFE or increase parameter 133 [Cnvrtr OL Factor].
8	HeatsinkOvrTp	The power structure heatsink temperature has exceeded the maximum allowable value. 85 °C = Alarm 90 °C = Fault	1. Verify that the maximum ambient temperature has not been exceeded. 2. Check the fans (including the ASIC board on the converter). 3. Check for an excess load. 4. Verify that the airflow plate is installed. See page 4-12.
9	IGBT OverTemp	The output transistors have exceeded their maximum operating temperature due to an excessive load.	1. Verify that the maximum ambient temperature has not been exceeded. 2. Check the fan(s). 3. Check for an excess load.
10	System Fault	A hardware problem exists in the power structure.	1. Reset the fault and restart. 2. Verify the fiber optic connections. 3. Verify ASIC Board jumper connections from X9 to X15 (see Figure B.1 on page B-1). 4. Contact Technical Support. 5. If the problem persists, replace or repair the power structure.
12	AC OverCurr	The AC line current has exceeded the hardware current limit.	Check for an excessive load or other causes of excess current.
13	Ground Fault	A current path to earth ground exists that is greater than the parameter 082 [Ground I Lvl] value. The current must appear for 800 milliseconds before the unit will fault.	Using a digital voltmeter to check for low impedance to ground, verify the bus cables/bars between the: • Disconnect and AC input lines • Converter and LCL Filter • For AFE in IP20 enclosure: – Q0 input breaker and K1 input contactor, which includes the precharge disconnect – LCL Filter and K1 input cont. • For AFE in IP21 enclosure: – Q1 (MCCB) and Q0 disconnect switch, which includes the precharge disconnect – LCL Filter and Q1 (MCCB)
14	Power Structure Fault	A hardware problem exists in the power structure.	1. Cycle the power. 2. Contact Technical Support. 3. If the problem persists, replace the converter unit.

No.	Name	Description	Action *(if appropriate)*
17	LineSync Fail	One input of the known phase rotation is missing.	1. Check all user-supplied fuses. 2. Check the AC input line voltage.
21	Phase Loss	There is zero current in one of the three phases.	Check supply voltage, fuses, and cable.
29	Anlg In Loss	An analog input is configured to fault on a signal loss. A signal loss has occurred. Configure this fault with parameter 203 or 206 [Anlg In x Loss].	1. Verify parameter 203 or 206 [Anlg In x Loss] setting. Input signal level should be greater than or equal to 1.5V or 3 mA. 2. Check for broken/loose connections at the inputs.
30	MicroWatchdog	A microprocessor watchdog timeout has occurred.	1. Cycle the power. 2. Replace the Control board. See page 4-5.
31	IGBT Temp Hw	The AFE input current has exceeded the 1 minute overload rating.	Check for an excess load.
32	Fan Cooling	Fan is not energized at start command. This includes the power structure or LCL Filter fans.	1. If the LCL Filter fan is not operating, check the fan DC power supply board located in front of the LCL Filter fan. 2. If the power structure fan is not operating, check the fan inverter board in back of the converter fan. For additional information, see PowerFlex 700H, 700S, and 700AFE Drive Fan Systems Installation Instructions, publication PFLEX-IN029.
33	AutoReset Lim	The AFE unsuccessfully attempted to reset a fault and resumed running for the programmed number in parameter 053 [Auto Rstrt Tries]. You can enable/disable this fault with parameter 120 [Fault Config].	Correct the cause and manually clear the fault.
34	CAN Bus Flt	A sent message was not acknowledged.	1. Cycle the power. 2. Replace the Control board on the power structure. See page 4-5.
35	Application	Problem in application software with task overload.	Contact Technical Support.
37	HeatsinkUndTp	The ambient temperature around the power structure heatsink is too low.	Raise the ambient temperature.
44	Device Change	The new power unit or option board installed is a different type.	Clear the fault and verify the correct parameters for the new option board.
45	Device Add	A new option board was added.	Clear the fault.
47	NvsReadChksum	There was an error reading parameters 019 [Motoring MWh], 020 [Regen MWh], and 021 [Elapsed Run Time] from EEPROM.	1. Cycle the power. 2. Replace the Control board.See page 4-5.

No.	Name	Description	Action *(if appropriate)*
58	Start Prevent	Startup has been prevented.	1. Cancel prevention of startup if this can be done safely. 2. Remove Run Request.
65	I/O Removed	An I/O option board has been removed.	Clear the fault.
70	Power Unit	Incorrect output power device operation.	1. Check the power structure for damaged components. Replace if defective. 2. Replace the power structure.
71	Periph Loss	The 20-COMM-x communication adapter has a fault on the network side.	Check the DPI device event queue and corresponding fault information for the device.
81	Port DPI Loss	The DPI port has stopped communicating. A SCANport device was connected to a drive operating DPI devices at 500k baud.	1. Check the HIM connection. 2. If the adapter was not intentionally disconnected, check the wiring to the port. Replace the wiring, port expander, adapters, Control board, or complete AFE as required. 3. If an adapter was intentionally disconnected and the [Logic Mask] bit for that adapter is set to '1', this fault will occur. To disable this fault, set the bit in parameter 154 [Logic Mask] to '0' for the port in which the adapter is connected.
94	Hardware Enbl	An enable signal is missing from the control terminal block, only when jumper J5 is removed on the digitial I/O board.	1. Check the control wiring. 2. Check the position of the J5 hardware enable jumper. 3. Check the digital input programming.
100	Param Chksum	The checksum read from the Control board does not match the checksum calculated.	1. Restore the AFE to the factory defaults. 2. Cycle the power. 3. Replace the Control board in the power structure. See page 4-5.
104	PwrBrd Chksum	The checksum read from the EEPROM does not match the checksum calculated from the EEPROM data.	1. Cycle the power. 2. Check the fiber optics between the Fiber Optic Adapter board and the ASIC board. See page C-1, page C-2, and page C-3 for connections. 3. Replace the Fiber Optic Adapter board (see page 4-6) and/or the ASIC board (see page 4-15) in the converter unit. 4. Contact Technical Support.
106	MCB-PB Config	The AFE rating information stored on the power board is incompatible with the Control board.	1. Reset the fault 2. Cycle the power. 3. Replace the Control board on the power structure. See page 4-5. 4. Contact Technical Support.

No.	Name	Description	Action *(if appropriate)*
107	New IO Option	A new option board was added to the Control board.	1. Clear the fault and verify the correct parameters for the new option board. 2. Reprogram parameters as necessary.
113	Fatal App	A Fatal Application error has occurred.	1. Cycle the power. 2. Replace the Control board on the power structure. See page 4-5.
120	I/O Change	An option board has been replaced.	Reset the fault.
121	I/O Comm Loss	A defective option board or I/O board slot.	1. Check the Control board-to-I/O option board connection. 2. Verify the ground integrity from the Control board to the option board. 3. Replace the Control board and/or I/O board. See page 4-5.
125	LCL OverTemp	The LCL Filter has been overheated or the signal is not connected to input.	Check the LCL Filter and signal connection or verify that digital input 5 is closed. See Chapter 7. There are nine total thermal switches connected in series to monitor temperature inside the coil of each filter inductor.  X52 is located on the LCL FIlter. X52 approximate location  Frame 13 LCL Filter
126	LCL Fan Stop	The LCL fan has been stopped.	Check the LCL fan. See Chapter 7. **NOTE:** This fault occurs only when the user has manually programmed a digital input as option '5'.

No.	Name	Description	Action *(if appropriate)*
128	Contact Fdbk	The input of the acknowledge signal from the main contactor is missing.	1. Check for closure on the following devices: – For AFE in IP20 enclosure, input contactor (K1) – For AFE in IP21 enclosure, MCCB (Q1) 2. Check digital input 4 on the Control board of the power structure.
133	DigInConflict	Digital input functions are in conflict.	Check the parameter settings of parameters 221…226.
138	DCRefLowLim	DC voltage reference is less than the limit in parameter 080 [DC Ref Lo Lmt].	1. Check the parameter setting. 2. Verify the bus voltage to be above the parameter value. 3. Troubleshoot the cause of the low voltage condition.
139	DCRefHighLim	DC voltage reference exceeds the limit in parameter 081 [DC Ref Hi Lmt].	1. Check the parameter setting. 2. Verify the bus voltage to be below the parameter value. 3. Troubleshoot the cause of the high voltage condition.
140	DCBusLoAlarm	DC voltage is less than the value set by parameter 078 [DC Bus Lo Alarm].	Check the parameter setting.
141	DCBusHiAlarm	DC voltage exceeds the value set by parameter 079 [DC Bus Hi Alarm].	Check the parameter setting.

Common Symptoms and Corrective Actions

AFE does not Start from Start or Run Inputs wired to the terminal block.

Cause	Indication	Corrective Action
AFE is faulted	Flashing red status light	Clear fault. • Press Stop • Cycle power • Set parameter 121 [Fault Clear] to ‘1’ • ‘Clear Faults’ on the HIM Diagnostic menu.
Incorrect input wiring. See the ‘Control Wiring’ section in the PowerFlex Active Front End User Manual, publication 20Y-UM001, for information. **NOTE:** Jumper from terminal 17 to 20 is required when using the 24V DC internal supply.	None	Wire inputs correctly and/or install jumper.
Incorrect digital input programming.	None	Program parameters 221…226 [Digital Inx Sel] for correct inputs. Run programming may be missing.
There is some other start inhibit.	Check status bits of parameter 100 [Start Inhibits].	Correct the source of the inhibit.

Instability in the AC Line Input Current and DC Bus Voltage.

Cause	Indication	Corrective Action
AC line voltage more than 5% above normal.	Instability in AC line current and DC bus voltage. May trip on fault F7 'Overload'.	Increase parameter 060 [DC Volt Ref] proportional to the percentage of the AC line voltage above nominal.
Negative reactive I Ref on parameter 065 [Reactive I Ref] with a soft (high impedance) AC line.	Instability in AC line current and DC bus voltage. May trip an F7 overload.	Change parameter 065 [Reactive I Ref] value to zero. Verify if the AFE is running on a soft line per the AC line source considerations.

Active Front End System Overview

This chapter describes AFE system main components and is grouped by those used in a IP20 2500 MCC Style enclosure, a IP21 Rittal enclosure, and main components for the AFE IP00 open chassis configuration.

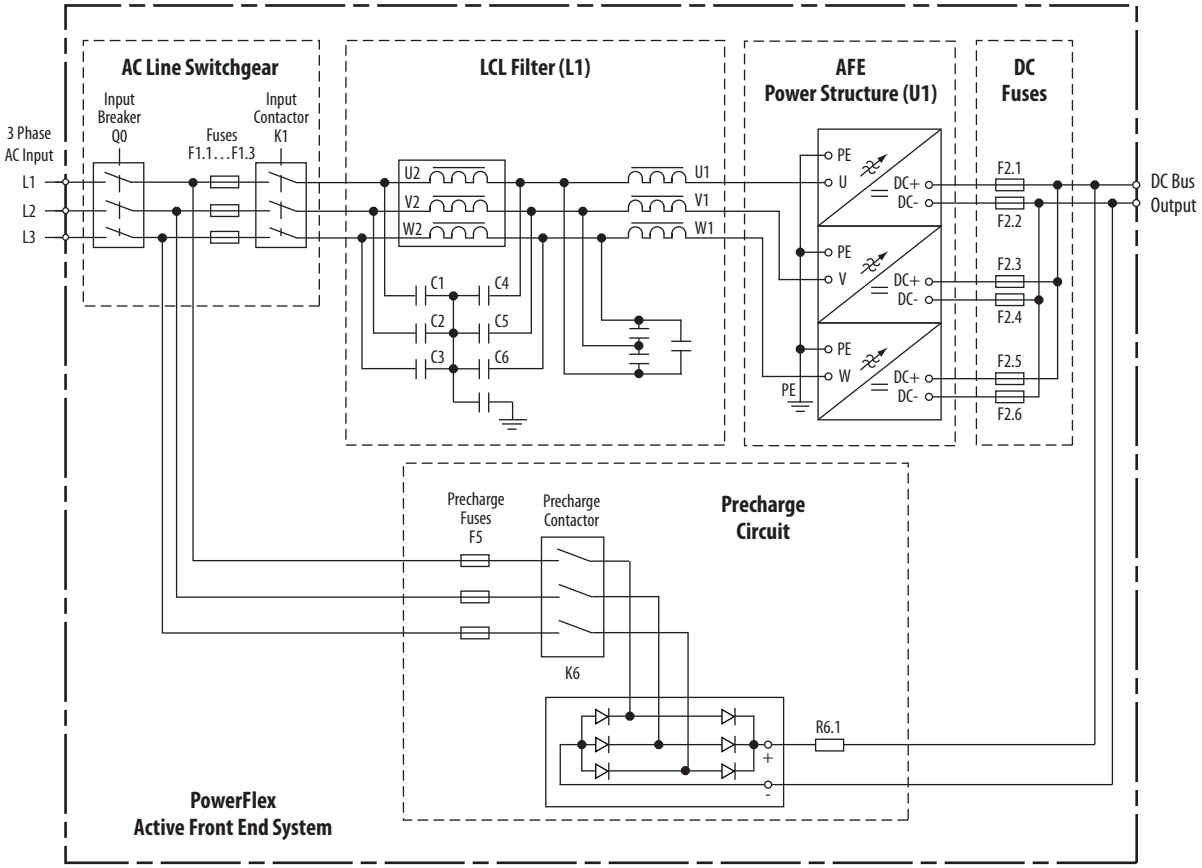
AFE in IP20 2500 MCC Style Enclosure

Main Component Sections

The following figure shows a basic one-line diagram for an AFE system in a IP20 2500 MCC Style enclosure. The main component sections consist of the following items:

- AC Line Switchgear consisting of the input circuit breaker (Q0), fuses (F1.1…F1.3), and input contactor (K1)
- LCL Filter (L1)
- Precharge Circuit
- AFE power structure (U1) with AFE control assembly
- DC Fuses (F2.1…F2.6)

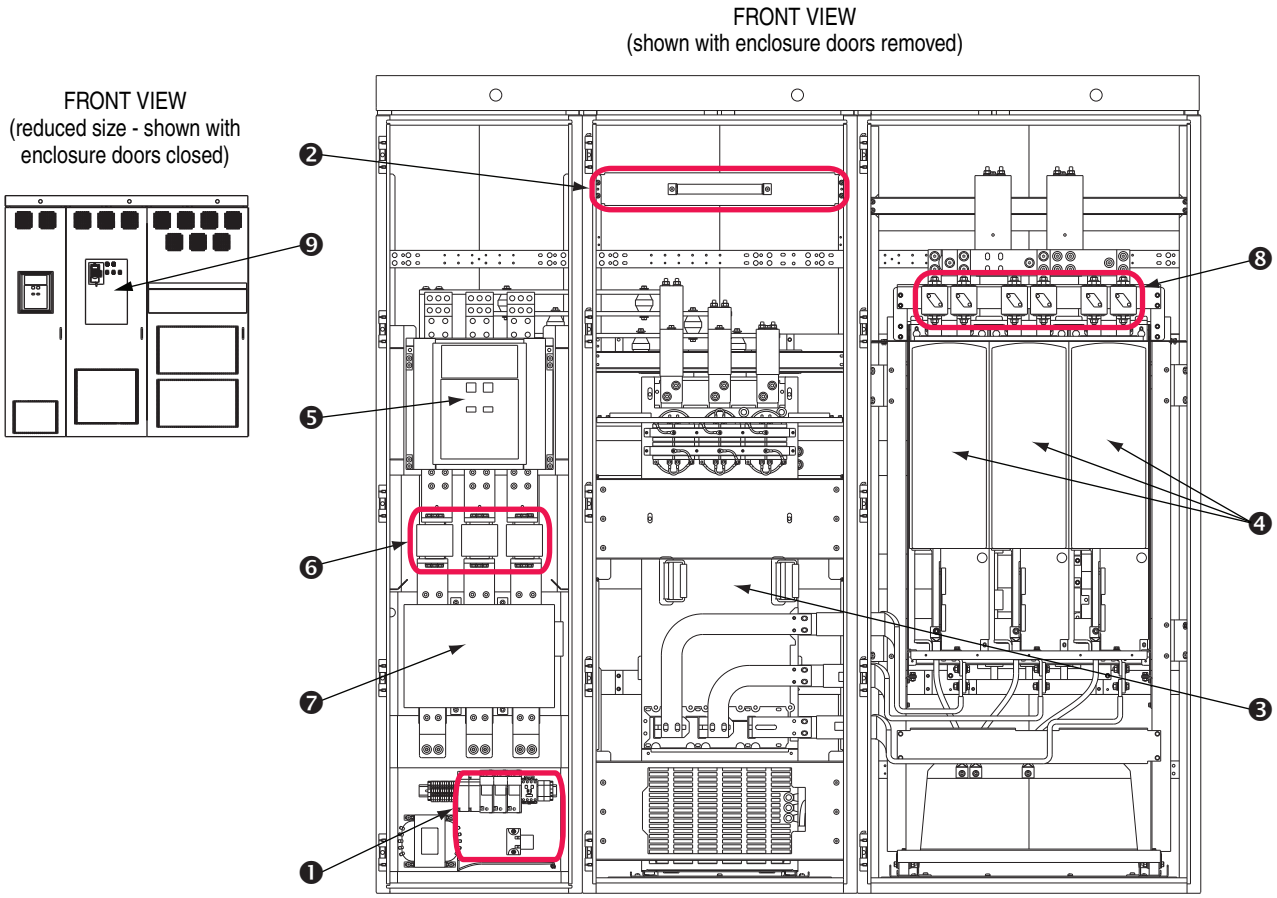
Figure 2.1 Basic One-line Diagram for AFE in IP20 2500 MCC Style Enclosure



Main Component Locations

The following figure shows the main components of the AFE Frame 13 system in a IP20 2500 MCC Style enclosure.

Figure 2.2 AFE Frame 13 Main Component Locations in IP20 2500 MCC Style Enclosure



Item	Description	
❶	Precharge Circuit	
❷	Precharge Resistor (R6.1)	
❸	LCL Filter (L1)	
❹	Active Front End Power Structure (U1)	
❺	AC Line Switchgear	Input Circuit Breaker (Q0)
❻		Input Fuses (F1.1…F1.3)
❼		Input Contactor (K1)
❽	DC Fuses (F2.1…F2.6)	
❾	AFE Control Box Assembly (on the AFE door and shown with user-installed HIM)	

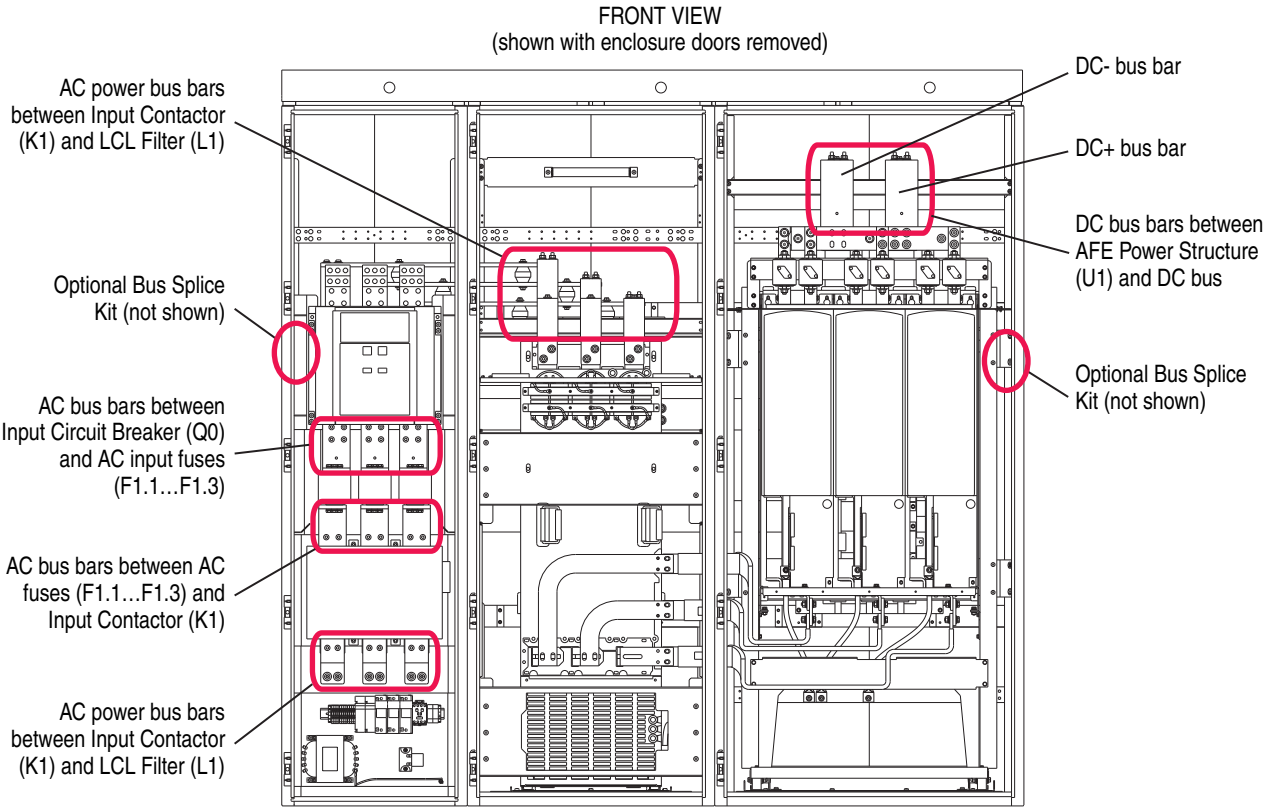
Main Bus Bar Locations

There are several sets of bus bars in the AFE Frame 13 system that connect main system components:

- Bus bars between Input Breaker (Q0) and AC Fuses (F1.1…F1.3)
- Bus bars between AC Fuses (F1.1…F1.3) and Input Contactor (K1)
- Bus bars between Input Contactor (K1) and the LCL Filter (L1)
- Bus bars between the AFE Power Structure (U1) and DC Bus

The following figure shows these bus bar locations.

Figure 2.3 AFE Frame 13 Bus Bar Locations in IP20 2500 MCC Style Enclosure


FRONT VIEW
(shown with enclosure doors removed)
AC power bus bars between Input Contactor (K1) and LCL Filter (L1)
Optional Bus Splice Kit (not shown)
AC bus bars between Input Circuit Breaker (Q0) and AC input fuses (F1.1…F1.3)
AC bus bars between AC fuses (F1.1…F1.3) and Input Contactor (K1)
AC power bus bars between Input Contactor (K1) and LCL Filter (L1)
DC- bus bar
DC+ bus bar
DC bus bars between AFE Power Structure (U1) and DC bus
Optional Bus Splice Kit (not shown)

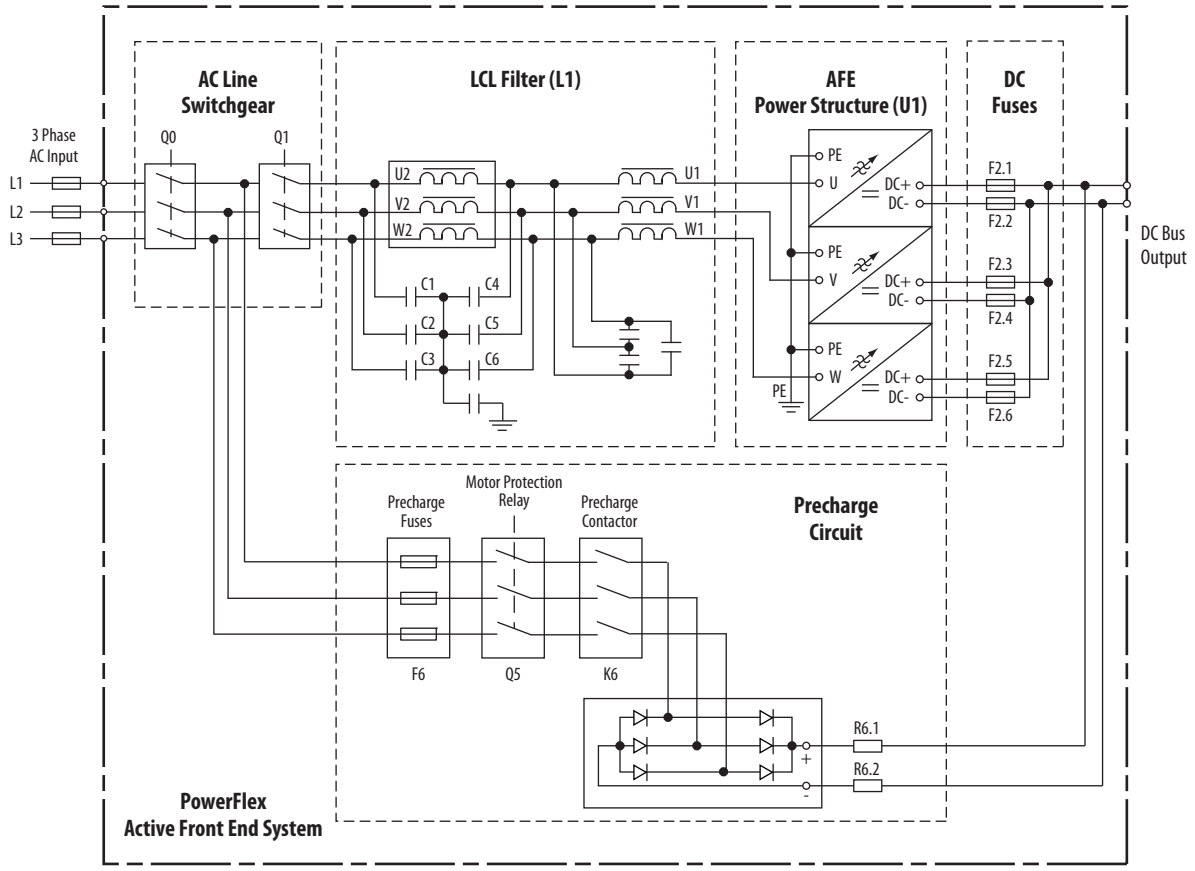
AFE in IP21 Rittal Enclosure

Main Component Sections

The following figure shows a basic one-line diagram for an AFE system in a IP21 Rittal enclosure. The main component sections consist of the following items:

- AC Line Switchgear consisting of the input disconnect (Q0) and MCCB motor-controlled circuit breaker (Q1)
- LCL Filter (L1)
- Precharge Circuit
- AFE Power Structure (U1) with AFE control assembly
- DC Fuses (F2.1…F2.6)

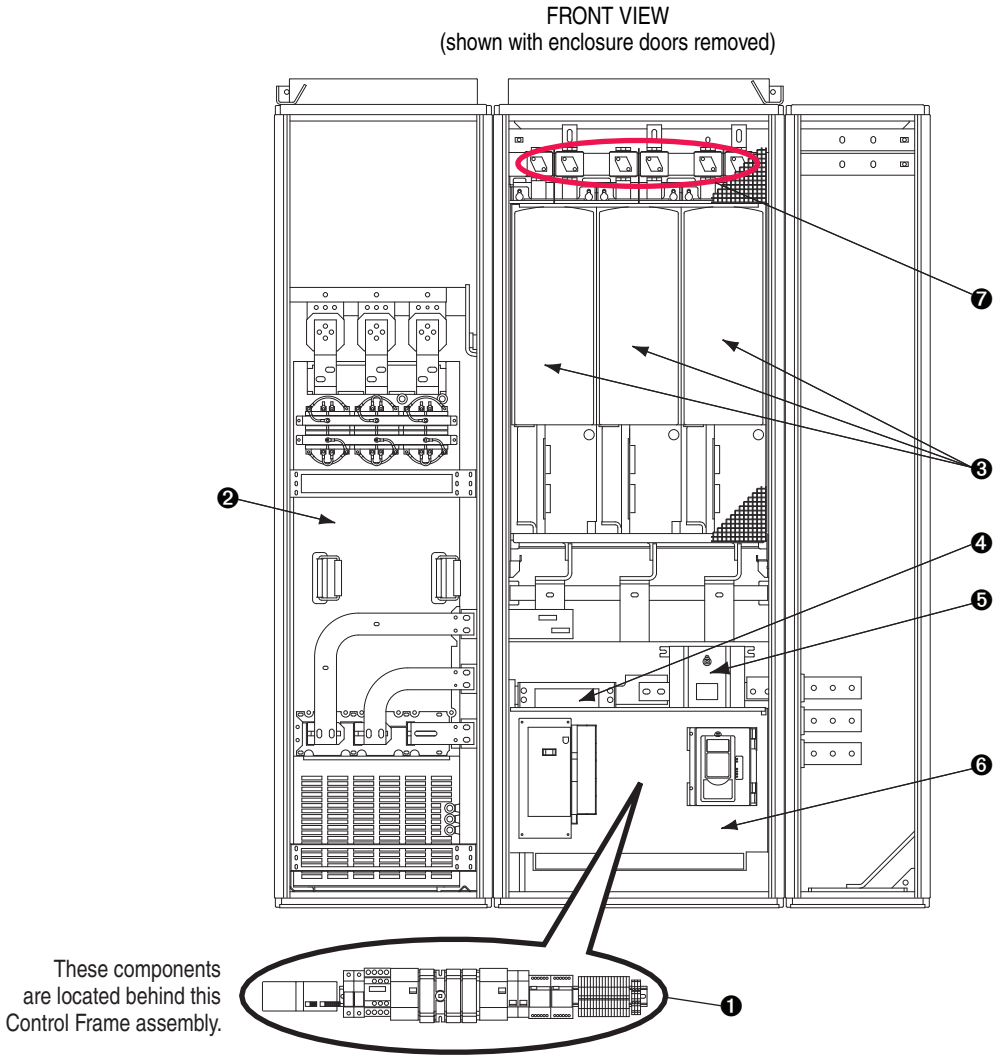
Figure 2.4 Basic One-line Diagram for AFE in IP21 Rittal Enclosure



Main Component Locations

The following figure shows the main components of the AFE Frame 13 system in a IP21 Rittal enclosure.

Figure 2.5 AFE Frame 13 Main Component Locations in IP21 Rittal Enclosure



Item	Description	
❶	Precharge Circuit and Precharge Resistors (R6.1 and R6.2)	
❷	LCL Filter (L1)	
❸	Active Front End Power Structure (U1)	
❹	AC Line Switchgear	Motor-controlled Circuit Breaker (Q1)
❺		Input Disconnect (Q0)
❻	AFE Control Assembly (shown with user-installed HIM	
❼	DC Fuses (F2.1…F2.6)	

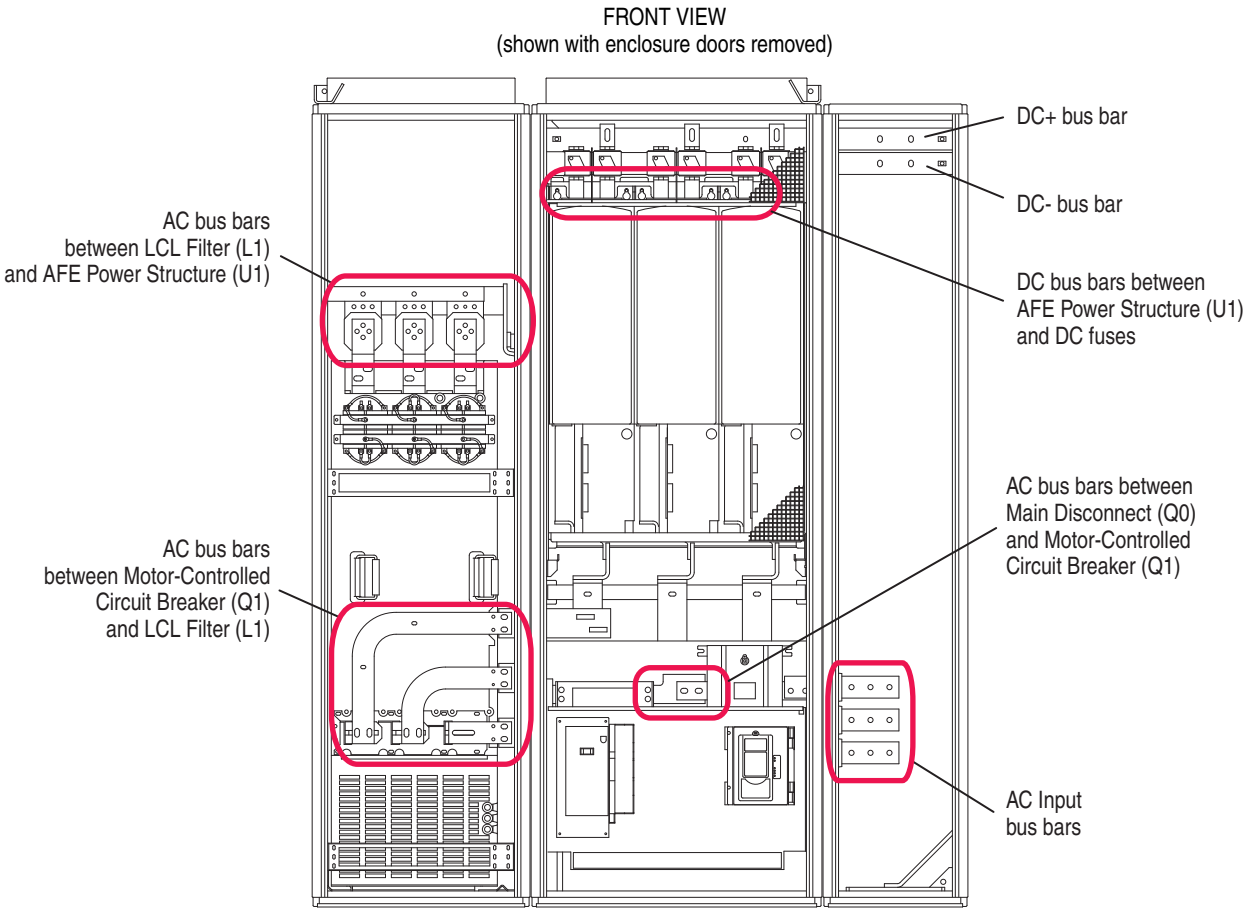
Bus Bar Locations

There are several sets of bus bars in the AFE Frame 13 system that connect main system components:

- Bus bars between Input Disconnect (Q0) and MCCB (Q1)
- Bus bars between MCCB (Q1) and the LCL Filter (L1)
- Bus bars between the LCL Filter (L1) and AFE Power Structure (U1)
- Bus bars between the AFE Power Structure (U1) and DC Bus Bars

The following figure shows these bus bar locations.

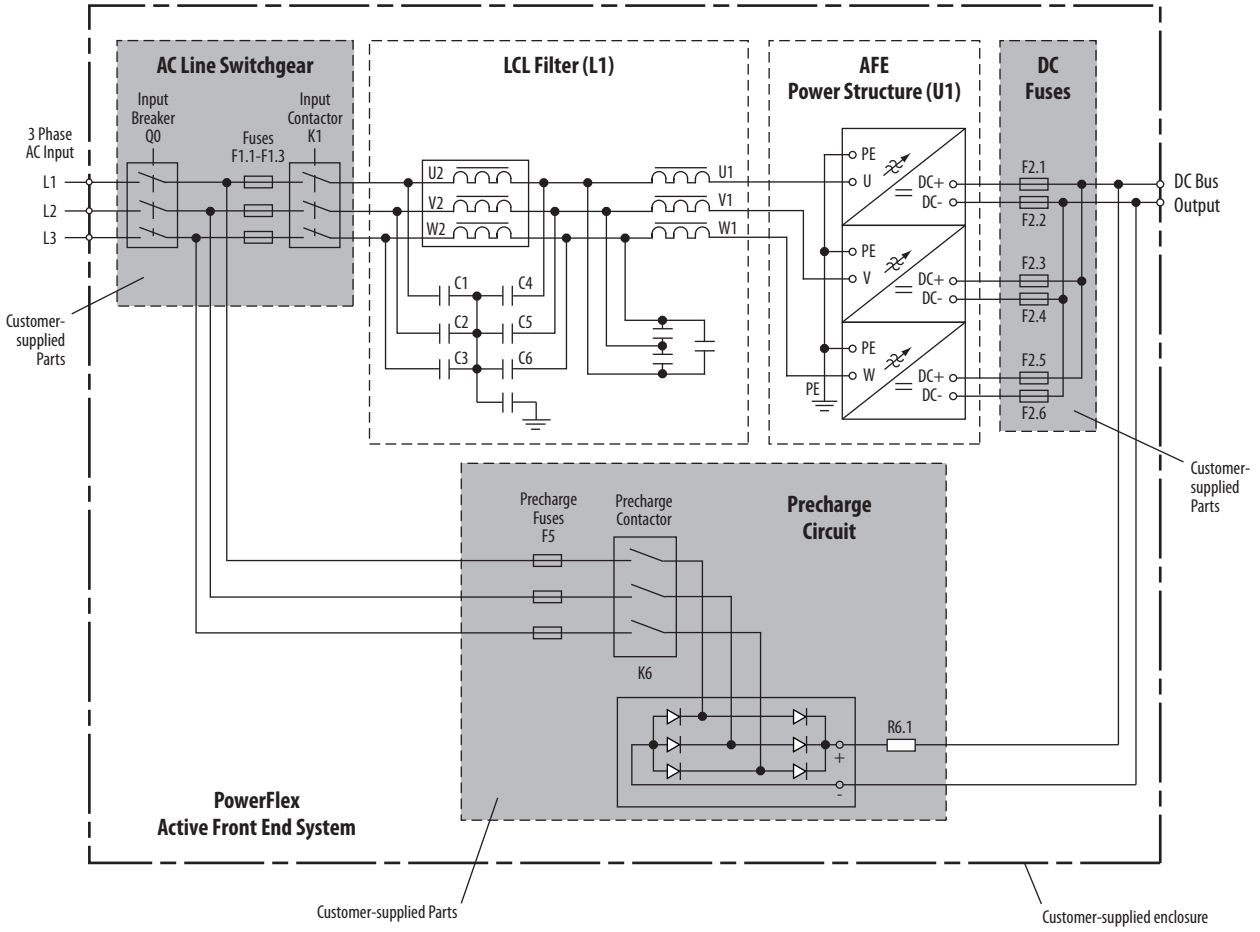
Figure 2.6 AFE Frame 13 Bus Bar Locations in IP21 Rittal Enclosure



AFE in IP00 Open Chassis Configuration

The following figure shows a basic one-line diagram for an AFE system in a IP00, NEMA/UL Open Chassis configuration and the parts the customer must supply.

Figure 2.7 Basic One-line Diagram for AFE in IP00 Open Chassis Configuration



Notes:

Component Test Procedures

ATTENTION: The sheet metal cover and mounting screws on the ASIC Board located on the power structure are energized at (-) DC bus potential high voltage. Risk of electrical shock, injury, or death exists if someone comes into contact with the assembly.

ATTENTION: To avoid an electric shock hazard, verify that all power to the PowerFlex Active Front End has been removed before performing any servicing or repairs.

ATTENTION: To avoid an electric shock hazard, verify that the voltage on the bus capacitors has discharged completely before servicing. Check the DC bus voltage between the +DC and -DC terminals, between the +DC terminal and the chassis, and between the -DC terminal and the chassis. The voltage must be zero for all three measurements.

ATTENTION: **Hot** surfaces can cause severe burns. **Do not touch** the heatsink surface during operation of the PowerFlex Active Front End. After disconnecting power allow time for cooling.

ATTENTION: Hazard of permanent eye damage exists when using optical transmission equipment. This product emits intense light and invisible radiation. Do not look into fiber optic ports or fiber optic cable connectors.

ATTENTION: The PowerFlex Active Front End contains electrostatic discharge (ESD) sensitive parts and assemblies that can be damaged if you do not follow ESD control procedures. Static control precautions are required to install, test, service, or repair this assembly. If you are unfamiliar with static control procedures, see Guarding Against Electrostatic Damage, publication 8000-4.5.2, or any other applicable ESD protection handbook.

Viewing the Status Indicators

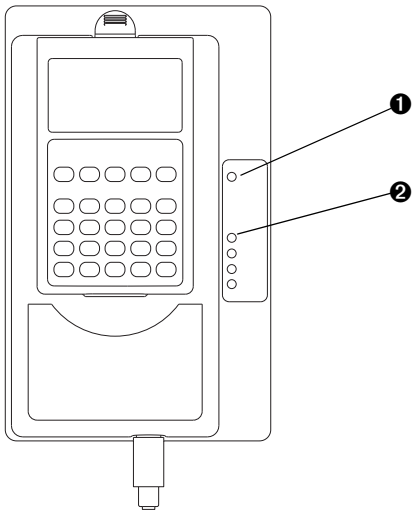


Table 3.A AFE Status Indicator Descriptions

Item	Name	Color	State	Description
1	PWR (Power)	Green	Steady	Lights when power is applied to the AFE.
2	PORT (1)	See to the Communication Adapter User Manual, publication 20COMM-UMxxx		Status of DPI port internal communication (if present).
	MOD (1)			Status of communication adapter (when installed).
	NET A (1)			Status of network (if connected).
	NET B (1)			Status of secondary network (if connected).

(1) These indicators operate only when a 20-COMM-X communication adapter is installed in the AFE and operating on the connected network.

Performing Visual Inspections

Important: Always remove power from the Active Front End before performing visual inspections. See Removing Power from the AFE on page 4-3.

Inspecting the Cooling Tunnels

1. Remove the main cooling fans from the bottom of the power structure.

   For details, see the PowerFlex 700S, 700H, and 700AFE Drive Fan Systems Installation Instructions, publication PFLEX-IN029.

2. Inspect the tunnels.

   Clean the heatsinks and tunnels if necessary.

Inspecting the Power Structure

1. Remove the protective barriers.

   See Removing AFE Protective Barriers on page 4-10.

2. Remove the protective front covers and terminal covers from the power structure for each phase (U, V, and W).

   See Removing Protective Covers from the Power Structure on page 4-13.

3. Check components for burn marks, breakage, or foil delamination on circuit boards.

   Check all the boards on the power structure.

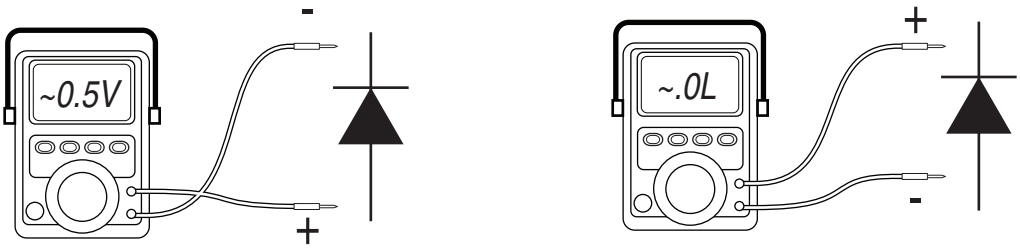
   Replace any of these components if they show evidence of burn marks, breakage, or foil delamination.

Performing Forward and Reverse Biased Diode Tests for Power Structure

A forward biased diode test checks the semiconductor junctions between the terminals and measures the voltage drop across those junctions. To pass each test, the meter must display a voltage near 0.5V. If the test finds a short, the meter displays '.000'. If the test finds an open circuit or reversed polarity, the meter displays '.0L' (zero load).

Important: The actual voltage readings can vary depending upon your equipment. If your readings are not near the indicated values in the following tables, verify that the actual voltage measured is consistent for the Power module.

A reverse biased diode test finds an open circuit, and the meter displays '.0L' (zero load).



Forward biased test on PN-junction

Reverse biased test on PN-junction

1. Remove power from the AFE.

   See Removing Power from the AFE on page 4-3.

2. Remove the protective barriers.

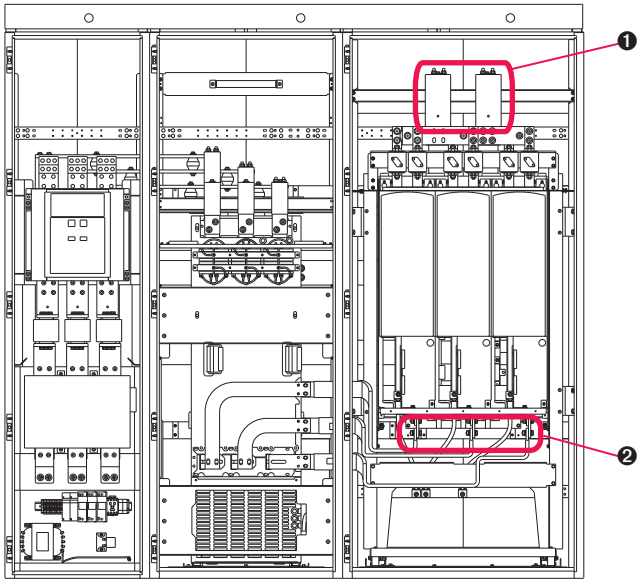
   See Removing AFE Protective Barriers on page 4-10.

3. Disconnect any drives connected to the DC bus from the DC bus, or remove the DC bus fuses from the AFE.

4. Conduct forward and reverse biased diode tests on the power structure.

Figure 3.1 Measurement Points for Forward and Reverse Diode Tests

Front View
(AFE in IP20 2500 MCC Style Enclosure shown with doors removed)



Front View
(AFE in IP21 Rittal Enclosure shown with doors removed)

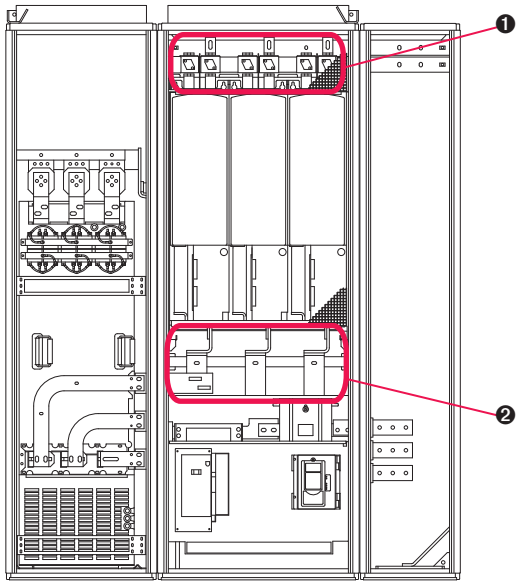


Table 3.B Forward Biased Diode Tests on Power Structure

Meter Leads		Location (see above)	Nominal meter reading
+	-		
DC-	U/T1	❶	Value should gradually rise to about 0.5V (1)
DC-	V/T2		
DC-	W/T3		
U/T1	DC+	❷	
V/T2	DC+		
W/T3	DC+		

(1) The actual voltage reading can vary depending upon your equipment. If your readings are not near 0.5V, verify that the actual voltage measured is consistent for the power structure.

Table 3.C Reverse Biased Diode Tests on Power Structure

Meter Leads		Location (see above)	Nominal meter reading
+	-		
U/T1	DC-	❶	Meter should display '.0L' (zero load)
V/T2	DC-		
W/T3	DC-		
DC+	U/T1	❷	
DC+	V/T2		
DC+	W/T3		

If the AFE fails any of these measurements, replace all Power Modules for each line phase in the power structure, or the complete power

structure using any of the following options:

- Contact your local representative to schedule On-site Services.
- Contact your local representative to make arrangements to return the power structure to the factory for repair by Remanufacturing Services.
- For an AFE not covered under factory warranty, a customer has the option of repairing the power structure using procedures described in this manual.

Checking Fiber Optic Connections

Damaged or improperly connected fiber optic cables can cause apparent Gate Driver board malfunctions. For fiber optic cable connections, see page C-1, page C-2, and page C-3.

1. Remove power from the AFE.

   See Removing Power from the AFE on page 4-3.

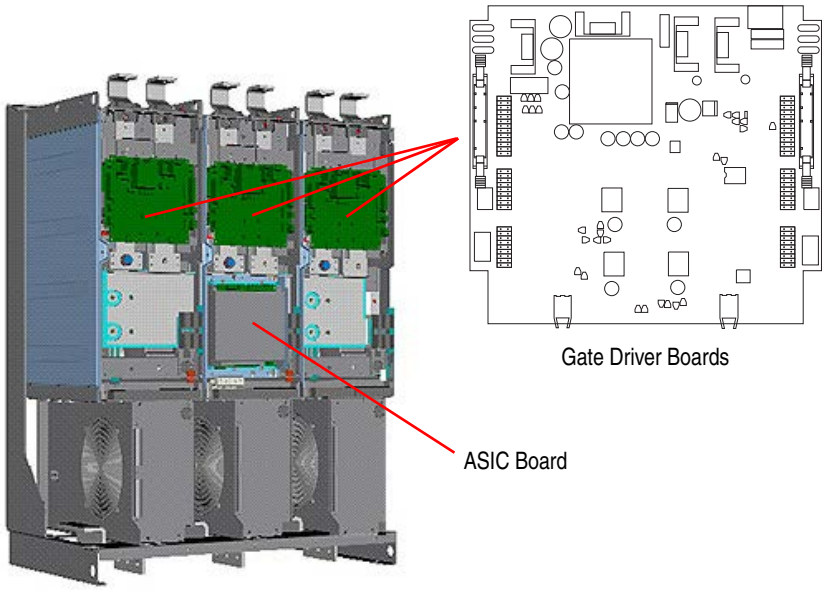
2. If present, remove the protective barriers.

   See Removing AFE Protective Barriers on page 4-10.

3. Remove the protective front covers and terminal covers from the power structure.

   See Removing Protective Covers from the Power Structure on page 4-13.

4. Locate the three Gate Driver boards on the front of the power structure (right-side AFE enclosure).



5. Verify that the fiber optic cables are properly connected between the Gate Driver boards and the ASIC board.

   Important: The minimum inside bend radius for fiber-optic cable is 25.4 mm (1 in.). Any bends with a shorter inside radius can permanently damage the fiber optic cable. Signal attenuation increases with decreased inside bend radii.

6. Verify that the fiber optic cables are properly connected between the ASIC board and the Fiber Optic Adapter circuit board.

7. Disconnect the cables and inspect them for scratches and cracks, and overall integrity.

   Important: When mishandled, the ability of fiber optic cables to transmit data is greatly diminished.

8. Reconnect the cables, replacing any damaged cables.

Performing Gate Driver Board Resistance Measurements

1. Remove power from the AFE.

   See Removing Power from the AFE on page 4-3.

2. If present, remove the protective barriers.

   See Removing AFE Protective Barriers on page 4-10.

3. Remove the protective front covers and terminal covers from the power structure for each phase (U, V, and W).

   See Removing Protective Covers from the Power Structure on page 4-13.

   There are three Gate Driver boards on the power structure, one for each phase (U, V, and W).

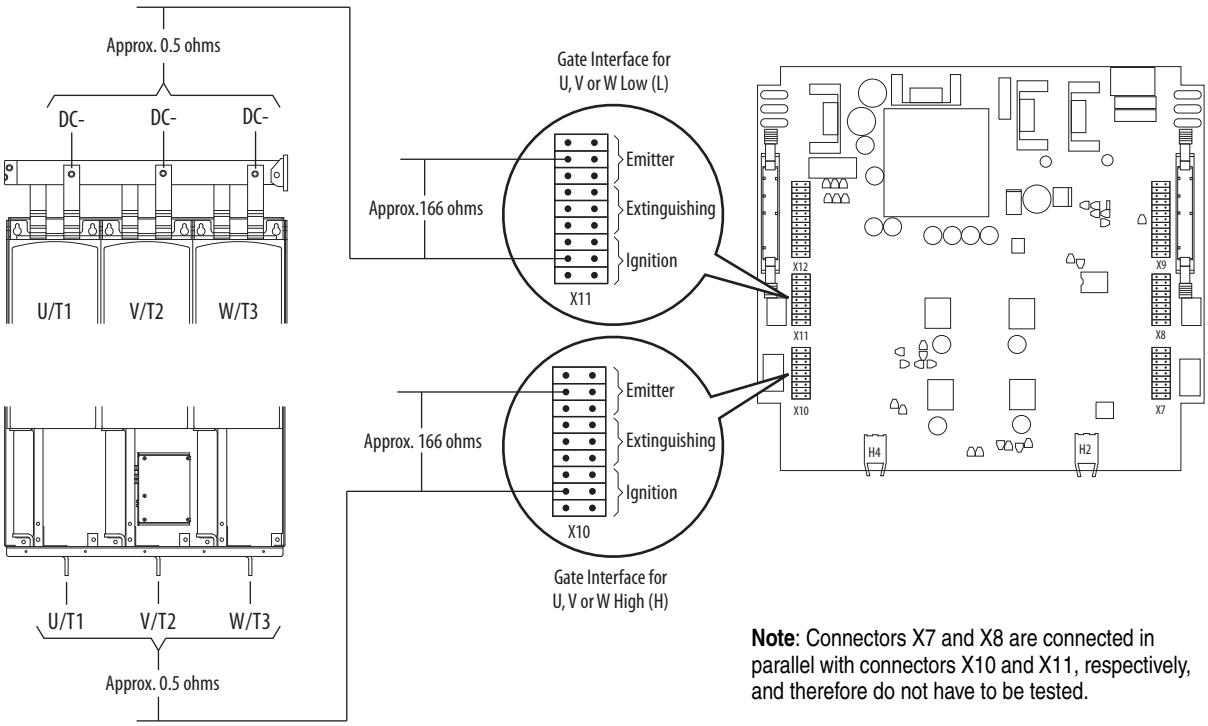
4. Measure the power transistor gate interface resistance for each phase (U, V, and W):

   – The resistance from each ignition pin to the branch emitter pin (connectors X10 and X11) is approximately 166 ohms.

   – The resistance from the X10 branch emitter pin to the same branch power terminal (U/T1, V/T2, and W/T3) is approximately 0.5 ohms.

   – The resistance from the X11 branch emitter to the same branch DC- bus terminal is approximately 0.5 ohms.

   If any of the gate interfaces fails this test, replace the appropriate (left, middle or right) power module. See Removing the Power Module from the U, V, or W Phase Assembly on page 4-25.



Note: Connectors X7 and X8 are connected in parallel with connectors X10 and X11, respectively, and therefore do not have to be tested.

Checking the AFE Power Structure Fan Inverter Fuses

1. Remove power from the AFE.

   See Removing Power from the AFE on page 4-3.

2. If present, remove the protective barriers.

   See Removing AFE Protective Barriers on page 4-10.

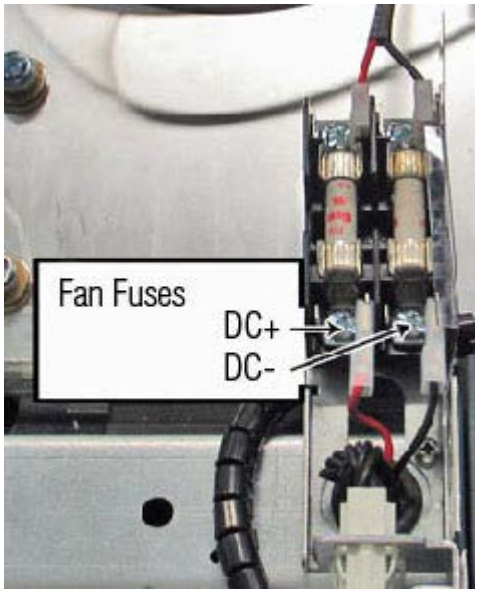
3. Remove the protective front covers and terminal covers from the power structure for each phase (U, V, and W).

   See Removing Protective Covers from the Power Structure on page 4-13.

4. A pair of fuses (F1 and F2) feed DC Bus power to each fan inverter.

   a. Locate these fuses (shown below) and remove them.

   b. Using a multi-meter, verify that they are not open.



5. Reinstall the good fuses and replace any open fuse with an equivalent-rated fuse.

AFE Power Structure Component Section

ATTENTION: To avoid an electric shock hazard, verify that all power to the PowerFlex Active Front End has been removed before performing any servicing or repairs.

ATTENTION: To avoid an electric shock hazard, verify that the voltage on the bus capacitors has discharged completely before servicing. Check the DC bus voltage between the +DC and -DC terminals, between the +DC terminal and the chassis, and between the -DC terminal and the chassis. The voltage must be zero for all three measurements.

ATTENTION: The sheet metal cover and mounting screws on the ASIC Board located on the power structure are energized at (-) DC bus potential high voltage. Risk of electrical shock, injury, or death exists if someone comes into contact with the assembly.

ATTENTION: **Hot** surfaces can cause severe burns. **Do not touch** the heatsink surface during operation of the PowerFlex Active Front End. After disconnecting power allow time for cooling.

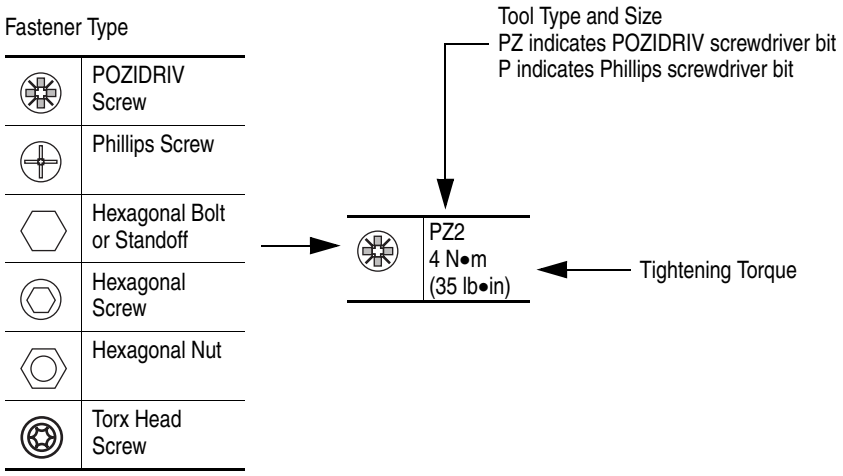
ATTENTION: Hazard of permanent eye damage exists when using optical transmission equipment. This product emits intense light and invisible radiation. Do not look into fiber optic ports or fiber optic cable connectors.

ATTENTION: The PowerFlex Active Front End contains electrostatic discharge (ESD) sensitive parts and assemblies that can be damaged if you do not follow ESD control procedures. Static control precautions are required to install, test, service, or repair this assembly. If you are unfamiliar with static control procedures, see Guarding Against Electrostatic Damage, publication 8000-4.5.2, or any other applicable ESD protection handbook.

Use the instructions in this chapter to remove and install components from the Active Front End. To remove and install components on the power structure and to remove a Power Module from the power structure, see Power Structure Access Procedures on page 4-10.

Understanding Torque Figures in Assembly Diagrams

Icons and numbers in the assembly diagrams indicate how to tighten hardware.



Torque Specifications

The following table lists fastener torque specifications for the circuit boards and main components of the Active Front End.

Item		Hardware	Final Torque
AC Input Terminals		M10 nut	40 N•m (354 lb•in)
ASIC Circuit Board (Mounting)		M4 x 8 POZIDRIV screws	0.9 N•m (8 lb•in)
ASIC Circuit Board Cover		M4 x 8 POZIDRIV screws	0.9 N•m (8 lb•in)
ASIC Fan		M4 x 16 POZIDRIV screws	0.4 N•m (3.5 lb•in)
Capacitor		M4 x 8 self tapping screws	1 N•m (9 lb•in)
DC-/DC+ Terminals		M6 x 20 POZIDRIV screws	5 N•m (44 lb•in)
DC Connective Bus Bars		M10 x 20 hexagonal screws	8 N•m (71 lb•in)
		M8 x 25 hexagonal socket-head screws	8 N•m (71 lb•in)
		M6 x 12 POZIDRIV screws	4 N•m (35 lb•in)
DPI/HIM Assembly Door		M3 x 6 Phillips screws	0.9 N•m (8 lb•in)
DPI/HIM Assembly (Mounting)		M3 x 6 Phillips screws	0.9 N•m (8 lb•in)
Fan Inverter Assembly		M5 x 10 POZIDRIV screws	4 N•m (35 lb•in)
Fan Inverter Fuse Base		M4 x 8 POZIDRIV screws	3 N•m (27 lb•in)
Fan Inverter Fuse Holder		M4 x 8 POZIDRIV screws	3 N•m (27 lb•in)
Gate Driver Circuit Board (Mounting)		M4 x 8 POZIDRIV screws	1.35 N•m (12 lb•in)
Main Cooling Fan (Mounting)		M5 x 10 POZIDRIV screws	3 N•m (27 lb•in)
Precharge Bridge Assembly	Wire Fasteners	M5 x 12 machine screws	4.5 N•m (40 lb•in)
	Mounting	M5 nuts	3.9 N•m (35 lb•in)
Precharge Bridge Resistor Assembly		M5 x 12 Torx self tapping screws	4.5 N•m (40 lb•in)
LCL Filter Upper Front Bracket	In IP20 Encl.	M8 x 20 / M6 x 16 screws	6.7 N•m (60 lb•in) / 4.5 N•m (40 lb•in)
	In IP21 Encl.	M5 x 12 Torx self tapping screws	4.5 N•m (40 lb•in)
Power Structure Input Terminals (U, V, W)	In IP20 Encl.	M10 x 40 bolt	37.9 N•m (336 lb•in)
	In IP21 Encl.	M8 x 20 bolt	20 N•m (177 lb•in)
Power Structure Block (Mounting)		M10 x 12 hexagonal screw	20 N•m (177 lb•in)
Power Structure DC Bus Terminals	In IP20 Encl.		
	In IP21 Encl.	M6 x 16 POZIDRIV	
Protective Covers on Power Structure	Front	M5 x 10 POZIDRIV	3 N•m (27 lb•in)
	Terminal	M5 x 16 POZIDRIV	3 N•m (27 lb•in)

POZIDRIV® is a registered trademark of the Phillips Screw Company.

Phillips® is a registered trademark of Phillips Screw Company.

Removing Power from the AFE

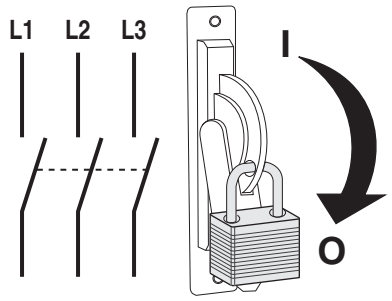
ATTENTION: To avoid an electric shock hazard, verify that the voltage on the bus capacitors has discharged completely before servicing. Check the DC bus voltage between the +DC and -DC terminals, between the +DC terminal and the chassis, and between the -DC terminal and the chassis. The voltage must be zero for all three measurements.

Remove power before making or breaking cable connections. When you remove or insert a cable connector with power applied, an electrical arc can occur. An electrical arc can cause personal injury or property damage by the following:

- Sending an erroneous signal to your system's field devices, causing unintended machine motion.
- Causing an explosion in a hazardous environment.

Electrical arcing causes excessive wear to contacts on both the module and its mating connector. Worn contacts can create electrical resistance.

1. Turn off and lock out input power.



2. Wait five minutes.
3. Verify that there is no voltage at the AFE input power terminals.
4. Check the DC bus voltage between the +DC and -DC terminals, between the +DC terminal and the chassis, and between the -DC terminal and the chassis.

   The voltage must be zero for all three measurements before proceeding.

Control Frame Access Procedures

Removing the DPI Interface Assembly

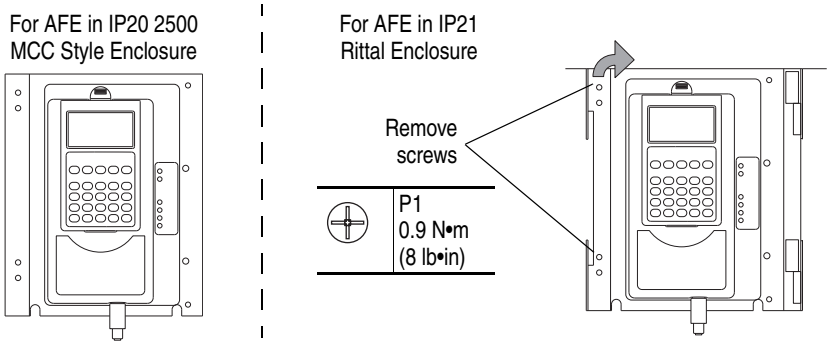
1. Remove power from the AFE.

   See Removing Power from the AFE on page 4-3.

   Important: Before removing connections and wires, mark them to avoid incorrect wiring during assembly.

2. For an AFE in a IP20 2500 MCC Style enclosure, disregard this step.

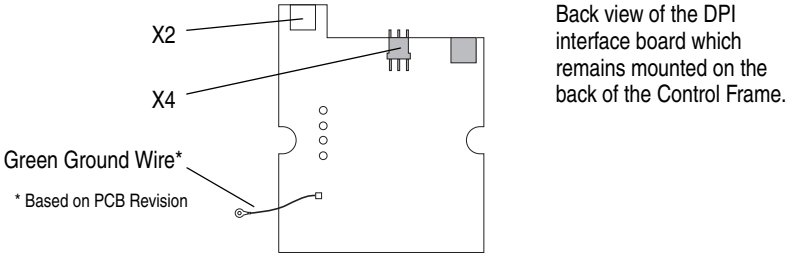
   For an AFE in a IP21 Rittal enclosure, locate the control assembly (item 6 in Figure 2.5), and remove the two screws from the front of the DPI hinged assembly.



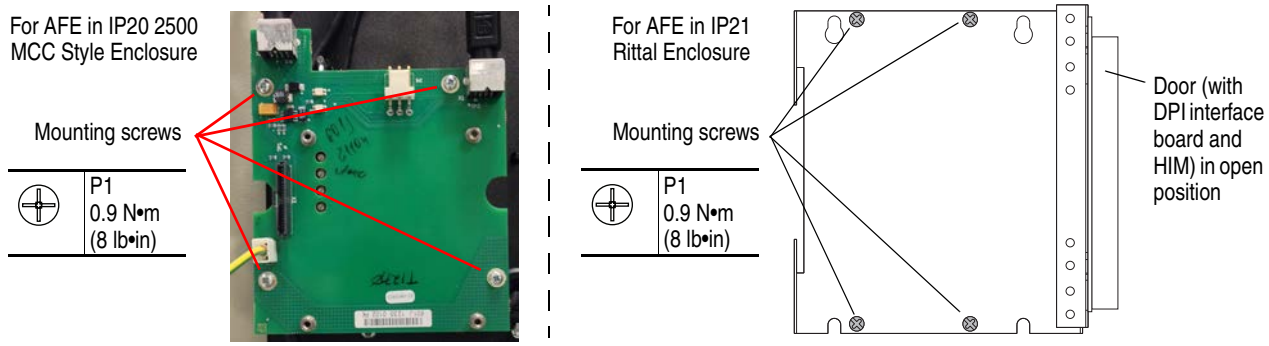
3. For an AFE in a IP20 2500 MCC Style enclosure, open the control box door to access the DPI interface board.

   For an AFE in a IP21 Rittal enclosure, open the hinged assembly that holds the DPI interface board.

4. Unplug the DPI cable from the X2 connector on the DPI interface board.


X2
X4
Green Ground Wire*
* Based on PCB Revision
Back view of the DPI interface board which remains mounted on the back of the Control Frame.

5. Remove the four screws and the assembly from the Control Frame.



Installing the DPI Interface Assembly

Install the DPI interface assembly in the reverse order of removal, while referring to Torque Specifications on page 4-2.

Removing the I/O Circuit Boards and Control Box

1. Remove power from the AFE.

   See Removing Power from the AFE on page 4-3.

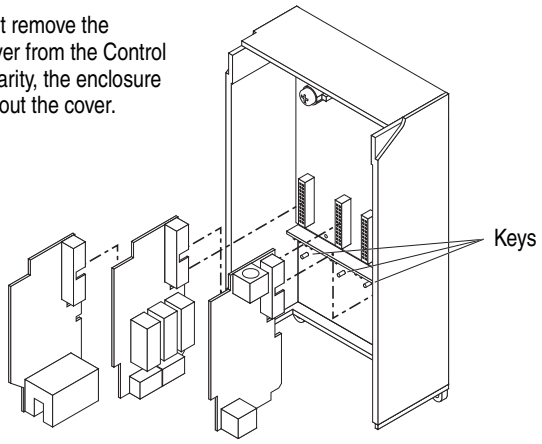
2. For an AFE in a IP20 2500 MCC Style enclosure, open the control box and carefully unplug the DPI cable and any I/O cables.

   For an AFE in a IP21 Rittal enclosure, open the enclosure that contains the control and I/O circuit boards and carefully unplug the DPI cable and any I/O cables.

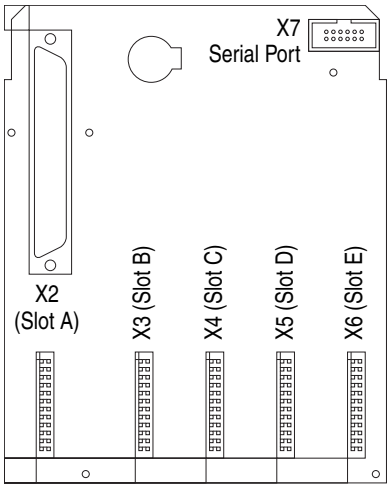
3. Remove the I/O boards from the Control board and enclosure.

   Note the order of the boards and the keys which prevent placement of boards in incorrect slots.

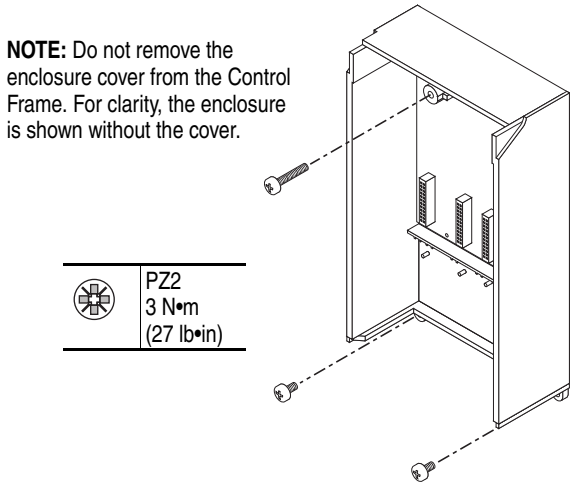
NOTE: Do not remove the enclosure cover from the Control Frame. For clarity, the enclosure is shown without the cover.



4. Unplug the serial connection from X7 of the Control board.



5. To remove the Control box, remove the three screws that secure it to the Control Frame.


NOTE: Do not remove the enclosure cover from the Control Frame. For clarity, the enclosure is shown without the cover.
PZ2
3 N•m
(27 lb•in)

Installing the I/O Circuit Boards and Control Box

Install the control box and I/O circuit boards in reverse order of removal, while referring to Torque Specifications on page 4-2.

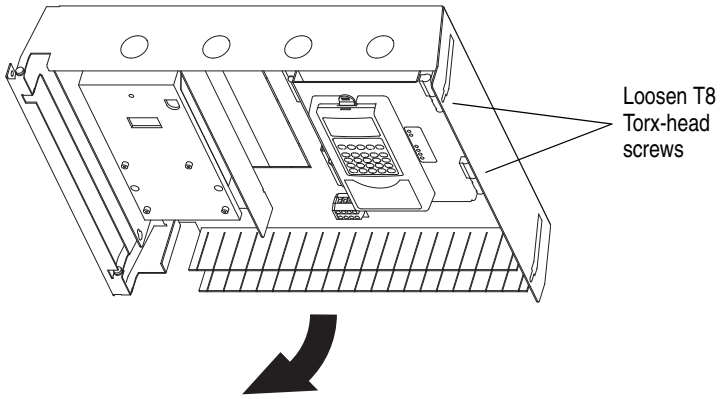
Removing the Fiber Optic Adapter Circuit Board

1. Remove power from the AFE.

   See Removing Power from the AFE on page 4-3.

2. For an AFE in a IP20 2500 MCC Style enclosure, open the control box on the enclosure door to access the Control assembly.

   For an AFE in a IP21 Rittal enclosure, see the following drawing and do perform these substeps:



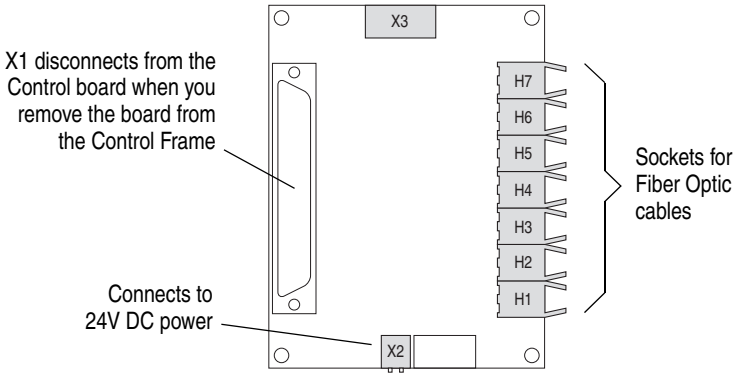
   a. Open the enclosure door to access the Control Frame.

   b. Loosen the T8 screws to open the Control Frame.

   c. Swing open the Control Frame, which exposes the back of the Control box to access the fiber optic adapter board.

3. Disconnect the cables from X2 and X3 of the Fiber Optic Adapter board.

   Important: Note polarity when removing X2 and X3 wires. If polarity is not maintained when re-installing these wires, the ASIC board or fiber optic board can be damaged.



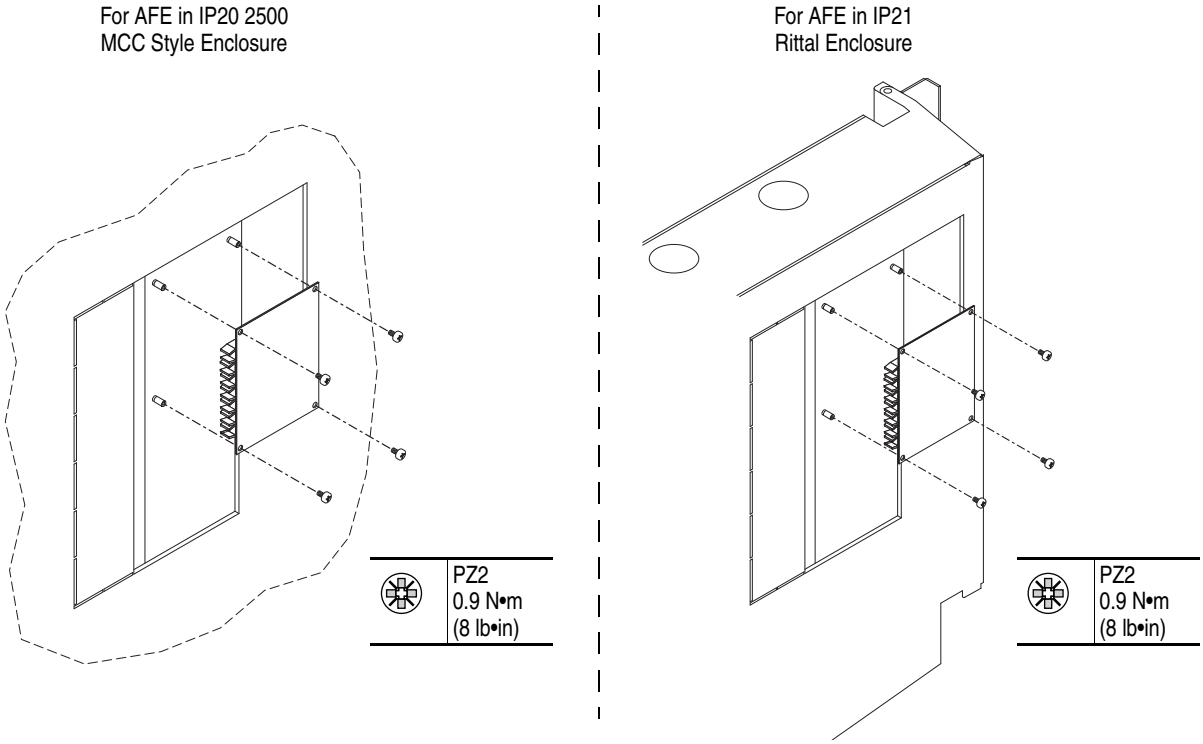
4. Carefully disconnect the fiber optic cables from the right side of the circuit board, and carefully set them aside.

   Important: When mishandled, the ability of fiber optic cables to transmit data is greatly diminished.

ATTENTION: Hazard of permanent eye damage exists when using optical transmission equipment. This product emits intense light and invisible radiation. Do not look into fiber optic ports or fiber optic cable connectors.

Important: The minimum inside bend radius for fiber-optic cable is 25.4 mm (1 in.). Any bends with a shorter inside radius can permanently damage the fiber optic cable. Signal attenuation increases with decreased inside bend radii.

5. Remove the four screws that secure the Fiber Optic Adapter board to the stand-offs on the back of the Control box (IP20) or Control Frame (IP21) and remove the Fiber Optic Adapter board.



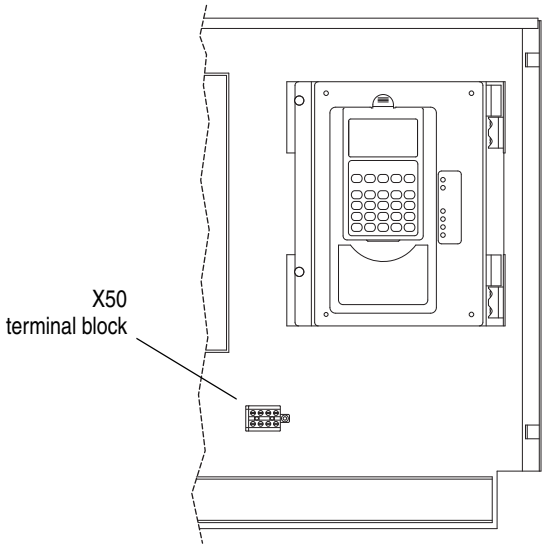
Installing the Fiber Optic Adapter Circuit Board

Install the Fiber Optic Adapter circuit board in reverse order of removal, while referring to Torque Specifications on page 4-2.

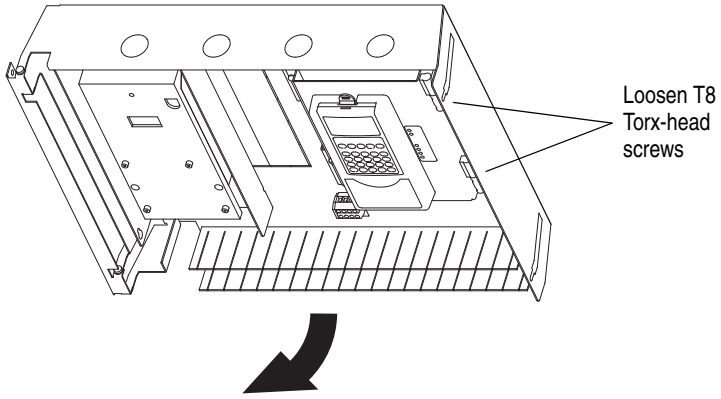
Removing the Control Frame (only for AFE in IP21 Rittal enclosure)

1. Remove power from the AFE.

   See Removing Power from the AFE on page 4-3.



2. Loosen the T8 Torx-head screws, which secure the Control Frame to the AFE enclosure.
3. Swing the Control Frame out and away from the power structure.
4. Lift the Control Frame from the hinges and remove it.



Replacing the Control Frame

Replace the control frame in reverse order of removal, while referring to Torque Specifications on page 4-2.

Power Structure Access Procedures

Follow these instructions to remove and install components on the power structure, and to remove Power Modules from the power structure.

Important: To access Power Modules for replacement requires the power structure to be completely removed from the AFE enclosure.

Removing AFE Protective Barriers

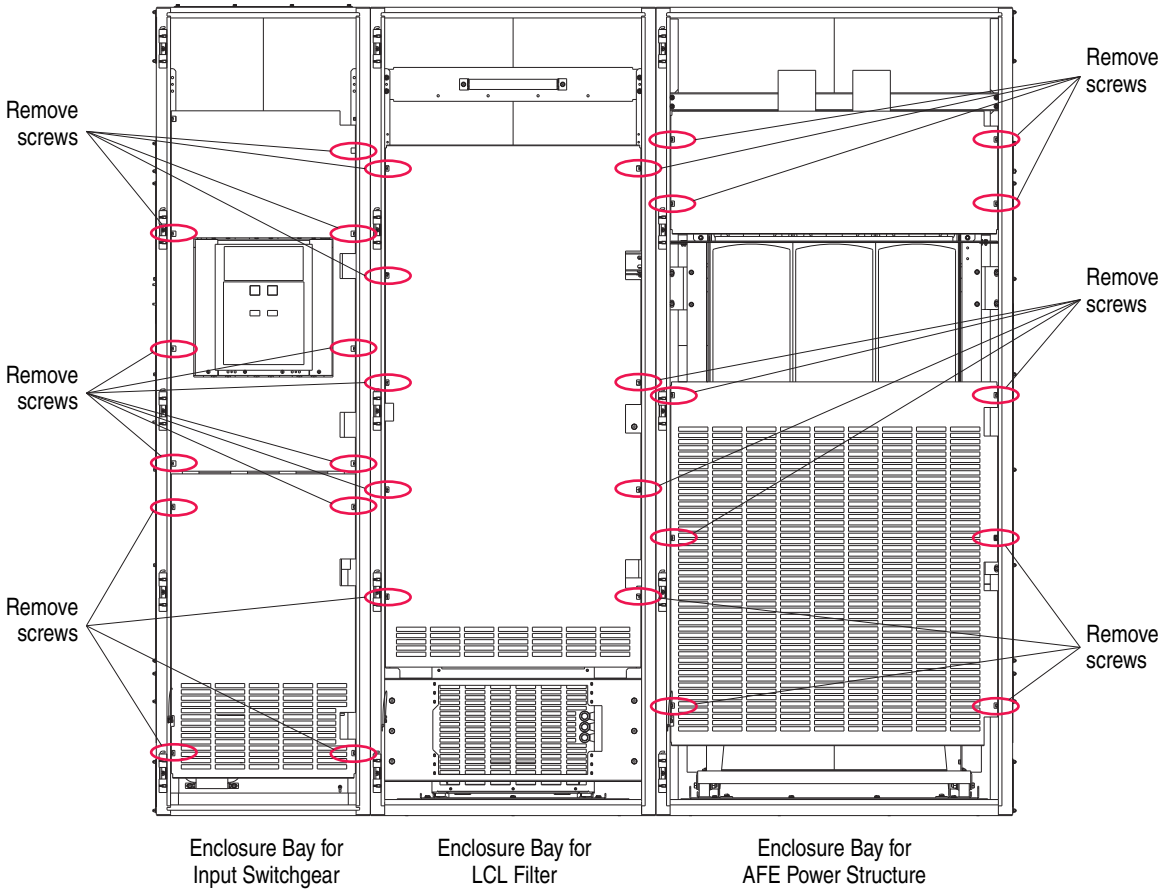
1. Remove power from the AFE.

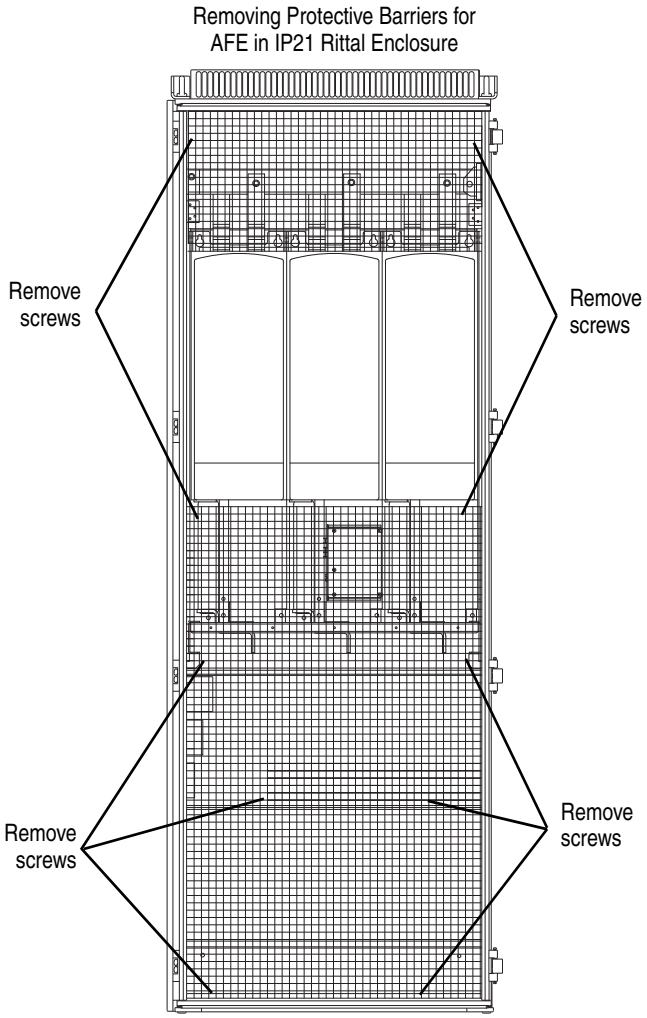
   See Removing Power from the AFE on page 4-3.

2. Remove the screws that secure the protective barriers to the AFE enclosure.

3. Remove the protective barriers.

Removing Protective Barriers for
AFE in IP20 2500 MCC Style Enclosure





Installing AFE Protective Barriers

Install the protective barriers in reverse order of removal.

Removing the AFE Air Flow Plate

You must remove the Air Flow Plate to remove the power structure from the AFE.

1. Remove power from the AFE.

   See Removing Power from the AFE on page 4-3.

2. If present, remove the protective barriers.

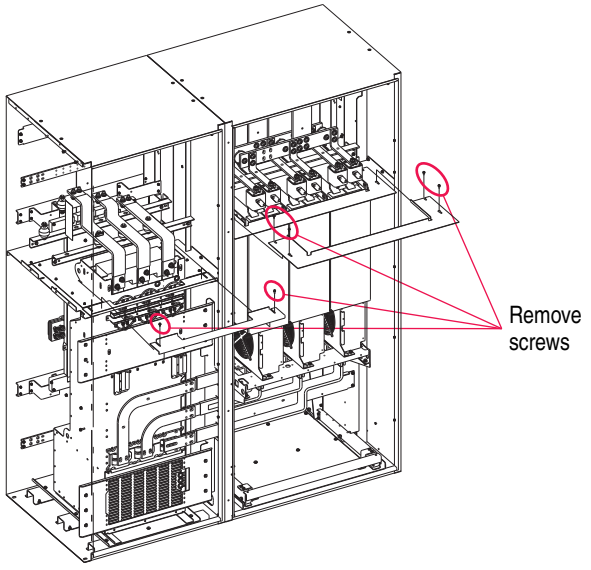
   See Removing AFE Protective Barriers on page 4-10.

3. For an AFE in a IP20 2500 MCC Style enclosure, remove the four M6 x 16 screws that secure the Air Flow Plate to the AFE, and remove the two M6 x 16 screws that secure the Air Flow Plate to the LCL filter.

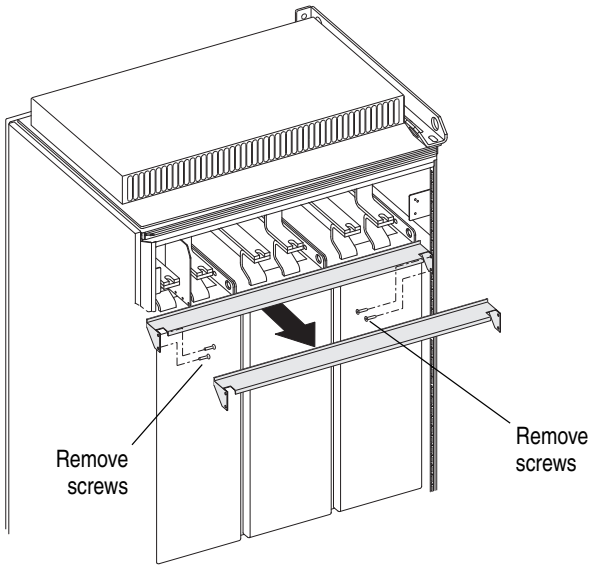
   For an AFE in a IP21 Rittal enclosure, remove the four T8 Torx-head screws that secure the Air Flow Plate to the AFE.

4. Slide the Air Flow Plate from the AFE.

Removing Air Flow Plate for AFE in IP20 2500 MCC Style Enclosure



Removing Air Flow Plate for AFE in IP21 Rittal Enclosure



Installing the AFE Air Flow Plate

Install the Air Flow Plate in reverse order of removal.

Removing Protective Covers from the Power Structure

You must remove the protective covers to access internal components of the power structure.

1. Remove power from the AFE.

   See Removing Power from the AFE on page 4-3.

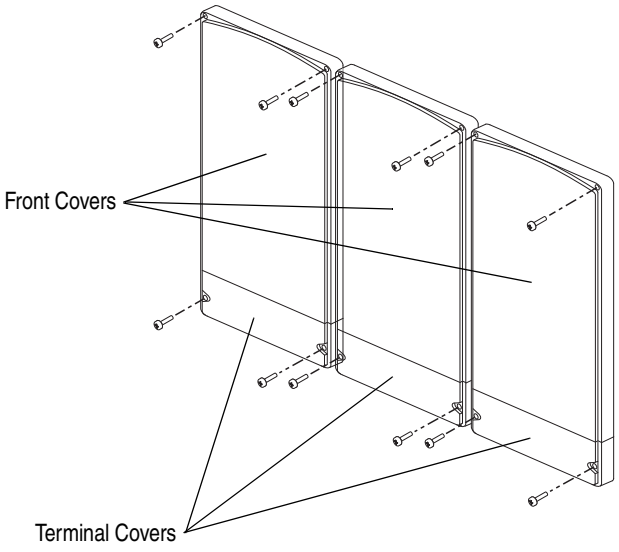
2. If present, remove the protective barriers.

   See Removing AFE Protective Barriers on page 4-10.

3. Remove the four M5 POZIDRIV screws that secure the protective front covers and terminal covers to the power structure.

4. Remove the covers.

   NOTE: You need to remove only the terminal covers to gain access to the cooling fan connections.



Installing Protective Covers on the Power Structure

Install the protective covers on the power structure in reverse order of removal, while referring to Torque Specifications on page 4-2.

Removing the Gate Driver Circuit Boards

There are three Gate Driver circuit boards on the front of the power structure.

1. Remove power from the AFE.

   See Removing Power from the AFE on page 4-3.

2. If present, remove the protective barriers.

   See Removing AFE Protective Barriers on page 4-10.

3. Remove the Air Flow Plate.

   See Removing the AFE Air Flow Plate on page 4-12.

4. Remove the protective front covers and terminal covers from the power structure.

   See Removing Protective Covers from the Power Structure on page 4-13.

5. Unscrew the terminals for the DC +/- supply from X1 of the first Gate Driver board.

   Observe polarity when removing for later re-attachment.

6. Carefully unplug the fiber optic cables from sockets along the bottom of the Gate Driver board, and carefully set them aside.

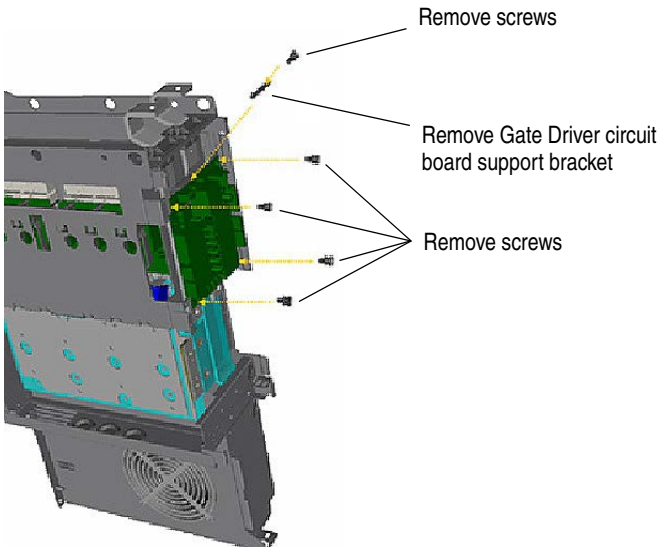
   Important: When mishandled, the ability of fiber optic cables to transmit data is greatly diminished.

ATTENTION: Hazard of permanent eye damage exists when using optical transmission equipment. This product emits intense light and invisible radiation. Do not look into fiber optic ports or fiber optic cable connectors.

   Important: The minimum inside bend radius for fiber optic cable is 25.4 mm (1 in.). Any bends with a shorter inside radius can permanently damage the fiber optic cable. Signal attenuation increases with decreased inside bend radii.

7. Disconnect the X13, X14, and X15 cables from sockets of the Gate Driver board, and set them aside.

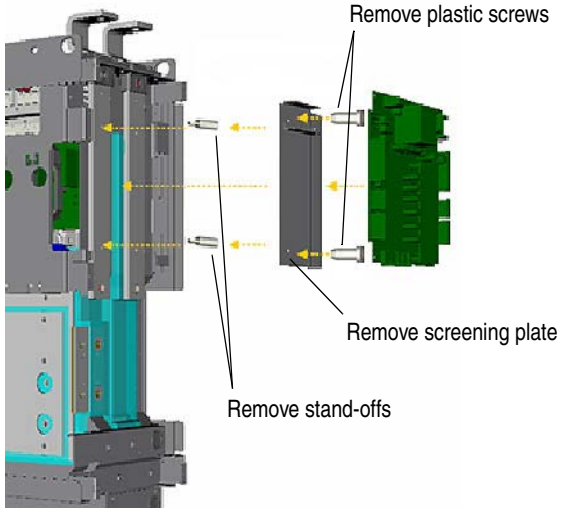
8. Remove the five screws that secure the Gate Driver board and support bracket to the power structure.



9. Carefully remove the Gate Driver board and the board support bracket.

10. Carefully remove the two plastic screws that secure the Gate Driver board screening plate to the power structure and remove the screening plate.

11. Remove the two stand-offs that support the Gate Driver board.



12. Repeat steps 5 through 11 for each of the remaining Gate Driver boards.

Installing the Gate Driver Circuit Boards

Install the Gate Driver circuit boards in the reverse order of removal.

Removing the ASIC Circuit Board

1. Remove power from the AFE.

   See Removing Power from the AFE on page 4-3.

2. If present, remove the protective barriers.

   See Removing AFE Protective Barriers on page 4-10.

3. Remove the Air Flow Plate.

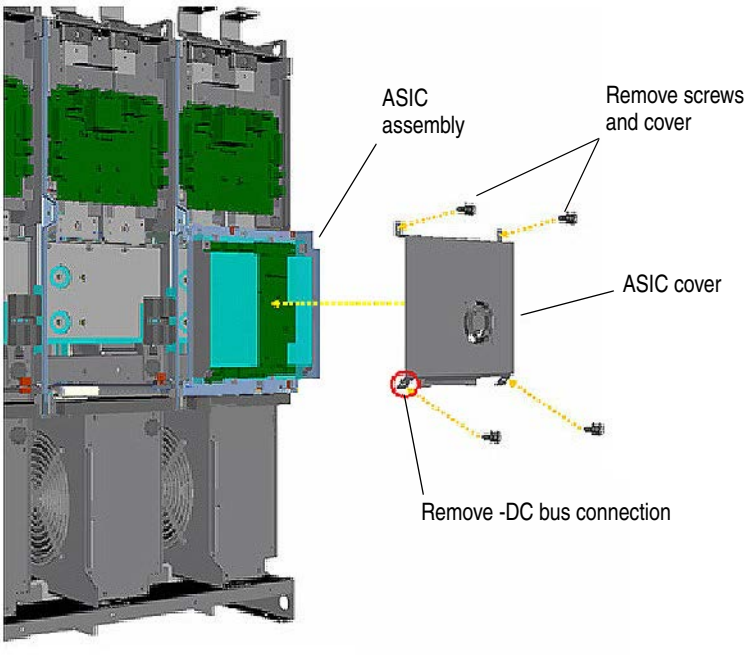
   See Removing the AFE Air Flow Plate on page 4-12.

4. Remove the protective front covers and terminal covers from the power structure.

   See Removing Protective Covers from the Power Structure on page 4-13.

ATTENTION: The sheet metal cover and mounting screws on the ASIC circuit board located on the power structure are energized at (-) DC bus potential high voltage. Risk of electrical shock, injury, or death exists if someone comes into contact with the assembly.

5. Remove the four screws that secure the ASIC cover to the ASIC assembly, remove the -DC bus connection from the ACSIC cover, and remove the ASIC cover.



6. Unplug the fan, which mounts on the cover, from connector X11 of the ASIC circuit board.

7. Carefully unplug the fiber optic cables H1 through H7 from sockets on the ASIC board, and carefully set them aside.

Important: When mishandled, the ability of fiber optic cables to transmit data is greatly diminished.

ATTENTION: Hazard of permanent eye damage exists when using optical transmission equipment. This product emits intense light and invisible radiation. Do not look into fiber optic ports or fiber optic cable connectors.

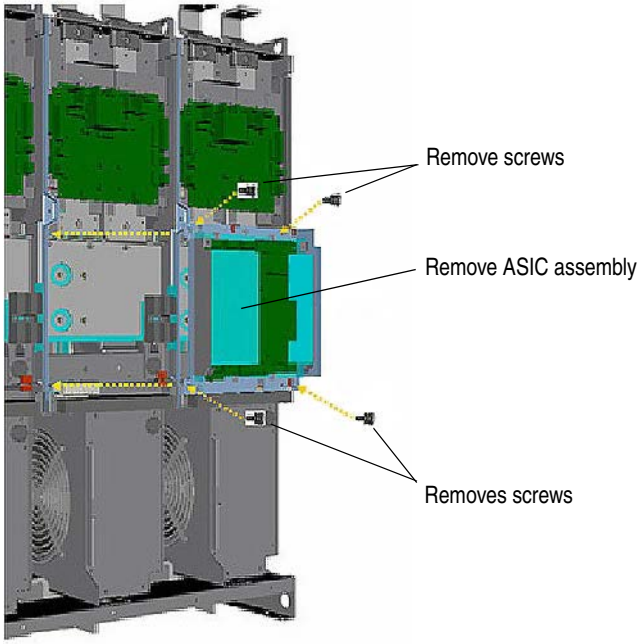
Important: The minimum inside bend radius for fiber optic cable is 25.4 mm (1 in.). Any bends with a shorter inside radius can permanently damage the fiber optic cable. Signal attenuation increases with decreased inside bend radii.

8. Disconnect the X9 terminal block and the X15 terminal connectors.

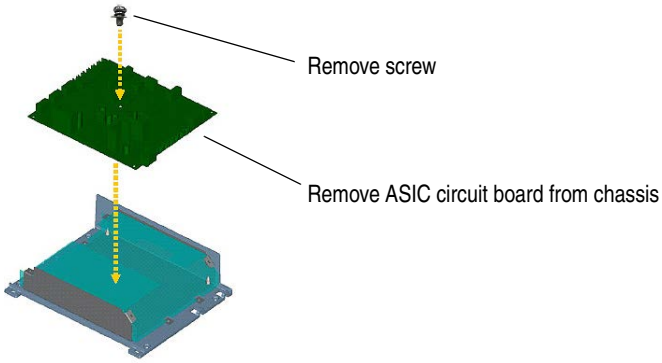
Note: When replacing the existing ASIC board with a new board, the X9 and X15 connectors must be transferred and connected to the new board before installation.

9. Disconnect the X3, X4, X5, X6, and X10 cables from sockets on the front of the ASIC board, and set them aside.

10. Remove the four screws that secure the ASIC assembly to the power structure and remove the ASIC assembly.

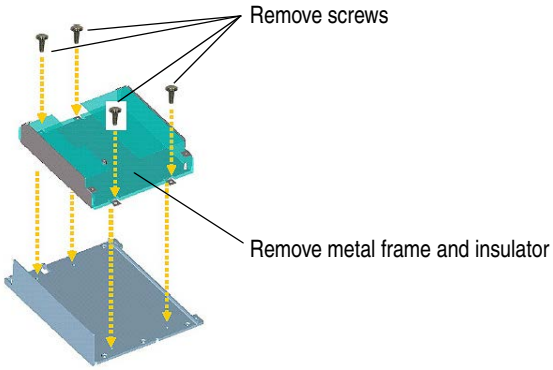


11. Remove the screw and detach the four plastic standoffs that secure the ASIC board to the ASIC chassis, and remove the ASIC board.

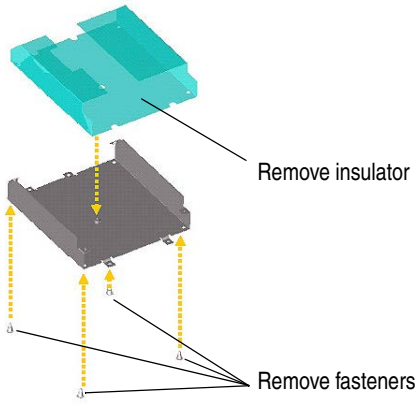


If the plastic insulator requires replacement, do the following:

a. Remove the four screws that secure the board holder to the metal frame, and remove the metal frame and insulator.



b. Carefully remove the four fasteners that secure the insulator to the metal frame, and remove the insulator.



c. Replace the insulator.

Installing the ASIC Circuit Board

Install the ASIC circuit board in reverse order of removal, while referring to Torque Specifications on page 4-2. Reconnect cables and jumpers to the ASIC board, while referring to Figure B.1 on page B-1.

ATTENTION: The sheet metal cover and mounting screws on the ASIC circuit board located on the power structure are energized at (-) DC bus potential high voltage. Risk of electrical shock, injury, or death exists if someone comes into contact with the assembly. Verify that the -DC bus wire is properly connected to the ASIC chassis cover.

Removing and Installing the Power Structure Fan System

There are three Main Cooling Fans on the power structure. For complete details on all fan system-related information, see the PowerFlex 700S, 700H, and 700AFE Drive Fan Systems Installation Instructions, publication PFLEX-IN029, including removal and installation of the following items:

- AC fan inverters
- AC fan capacitors
- AC main cooling fans
- DC fan power supplies
- DC main cooling fans
- Fan fusing

Removing the Power Structure from the Enclosure

Important: Power structure removal is required only when it, or its internal components (Power Module, DC bus capacitors, balancing resistors, and so forth) needs to be replaced.

1. Remove power from the AFE.

   See Removing Power from the AFE on page 4-3.

2. If present, remove the protective barriers.

   See Removing AFE Protective Barriers on page 4-10.

3. Remove the Air Flow Plate.

   See Removing the AFE Air Flow Plate on page 4-12.

4. Remove the DC+ and DC- wires from the Fan Inverter Fuse assemblies.

5. Disconnect the seven fiber optic cables connected to the fiber optic adapter board located behind the control assembly (for AFE in IP20 2500 MCC Style enclosure) or the Control Frame (for AFE inIP21 Rittal enclosure).

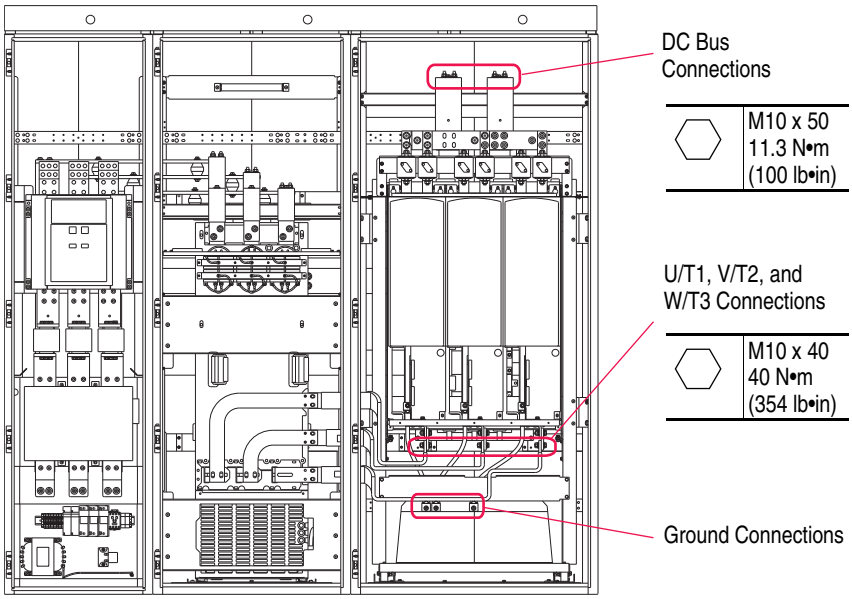
   For location of connections, see Removing the Fiber Optic Adapter Circuit Board on page 4-6.

6. Depending on the enclosure in which the AFE is installed, follow the appropriate procedure below to remove the power structure from the enclosure.

   AFE in IP20 2500 MCC Style Enclosure

   a. Disassemble the four M10 x 50 bolts and associated hardware that secure the DC+ and DC- bus bars of the AFE power structure to the MCC bus.

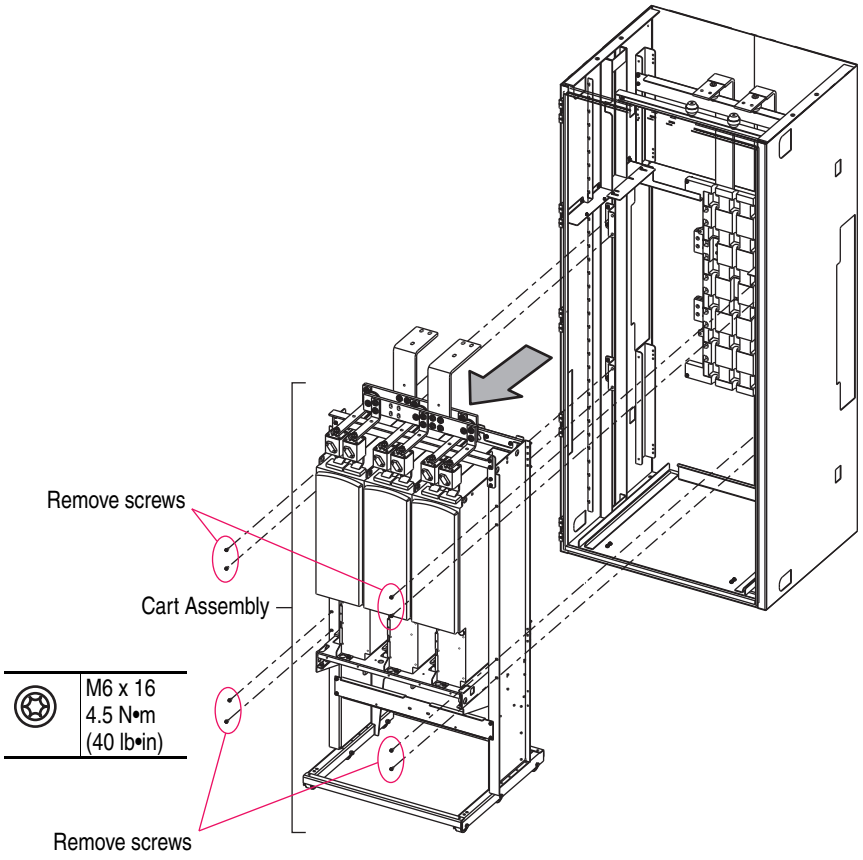
AFE in IP20 2500 MCC Style Enclosure
(shown with enclosure doors removed)



b. Remove the U/T1, V/T2, and W/T3 connections from the power structure at the bottom front of the power structure.

c. Remove the ground connections of the power structure from the enclosure PE terminals.

d. Remove eight M6 x 16 screws that secure the cart assembly to the enclosure.



ATTENTION: The cart assembly is heavy. To avoid personal injury or damage to the equipment, use caution when removing the cart assembly from the enclosure.

e. Roll the cart assembly which contains the power structure outward from the enclosure.

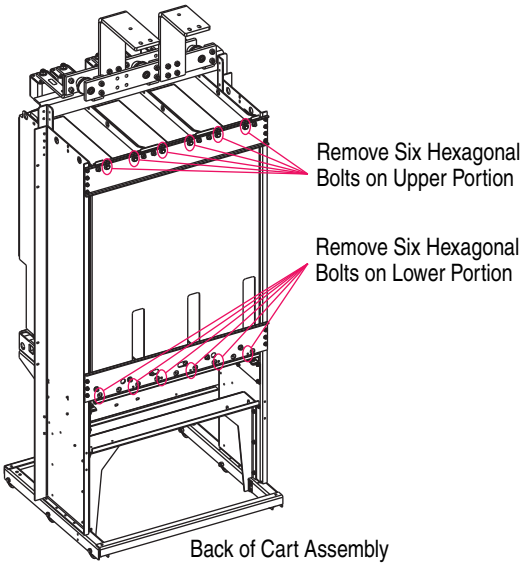
Note that ramps may be required due to floor mismatch.

When replacing the complete power structure, continue with the following substeps. When replacing components within an individual phase assembly, see Removing the U, V, or W Phase Assembly from the Power Structure on page 4-23.

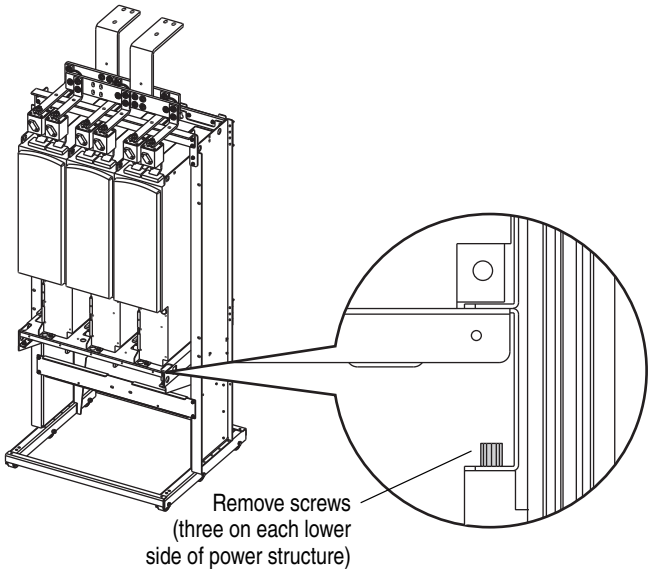
f. Secure appropriate lifting cables or chains to the recommended lift points on the power structure, and tighten the cables or chains.

For details, see Lifting and Mounting the PowerFlex Active Front End (AFE)—Frames 10 and 13, publication 20Y-IN001.

g. Remove the six hexagonal bolts from the upper portion of the chassis backside and the six hexagonal bolts from the lower portion of the chassis backside to detach the power structure from its cart assembly.



h. Remove the six hexagonal screws (three on each lower side) to detach the power structure from its cart assembly.



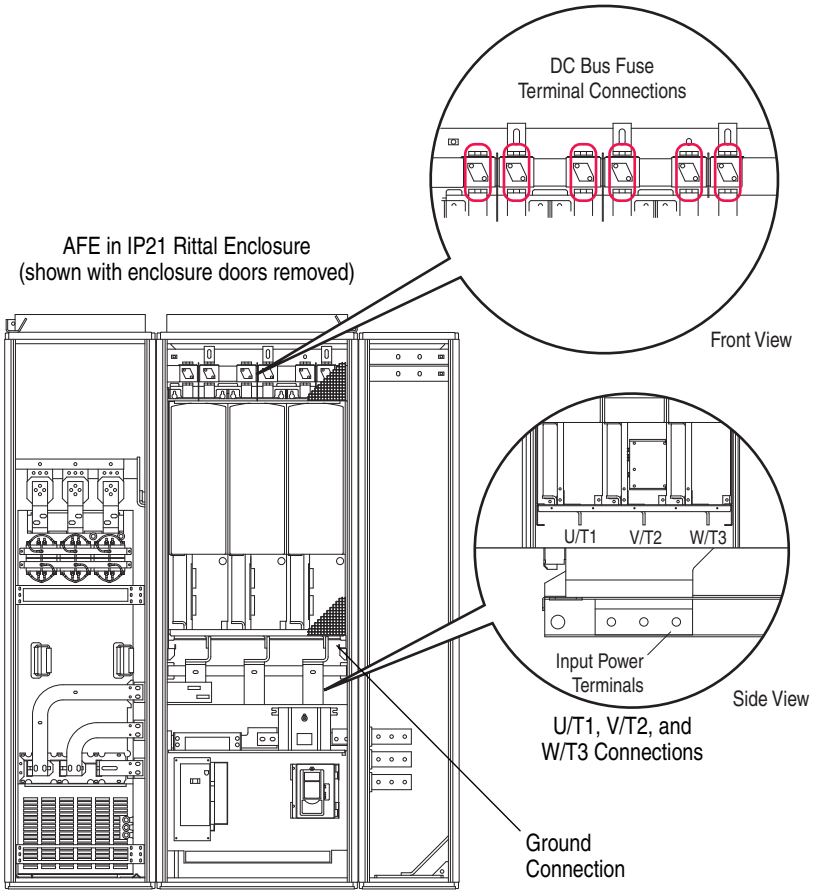
i. Remove the six DC output fuses (two per phase) from the power structure bus bars.

For DC fuse removal instructions, see Fuse Replacement Guidelines on page 8-2.

j. Separate the power structure from its cart assembly, and remove the power structure by using appropriate lifting equipment.

AFE in IP21 Rittal Enclosure

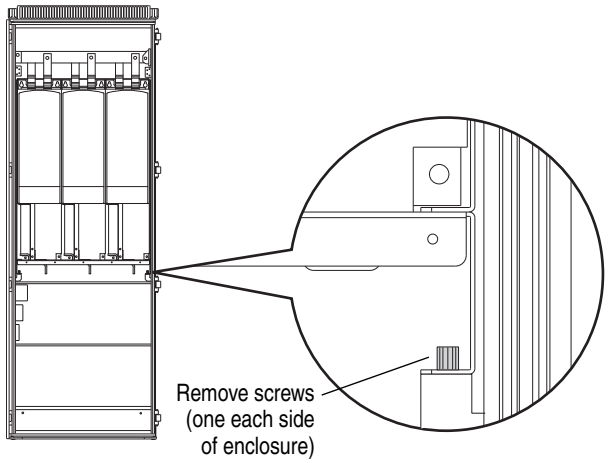
a. Remove the six DC bus fuses from the terminal connections at the top of the power structure.



b. Remove the U/T1, V/T2, and W/T3 connections from the power structure at the front of the power structure.

c. Remove the ground connections of the power structure from the enclosure PE terminals.

d. Remove the output cable fastening screws, and the two hexagonal screws that secure the power structure to the AFE frame.



e. Install the Maintenance Stand (catalog number 20-MAINSTD) onto the power structure rails.

For details, see Installation Instructions - PowerFlex 700S/700H High Power Maintenance Stand, publication PFLEX-IN014.

ATTENTION: The power structure is heavy. To avoid personal injury or damage to the equipment, use caution when removing the power structure from the enclosure.

f. Slide the power structure outward onto the rails of the optional Maintenance Stand.

Installing the Power Structure in the Enclosure

Install the power structure in reverse order of removal. See the PowerFlex Active Front End User Manual, publication 20Y-UM001, for tightening torques of AC supply, DC bus input, and ground connection terminations.

Removing the U, V, or W Phase Assembly from the Power Structure

Important: Do not attempt to disassemble the Power Module within the U, V, or W Phase Assembly.

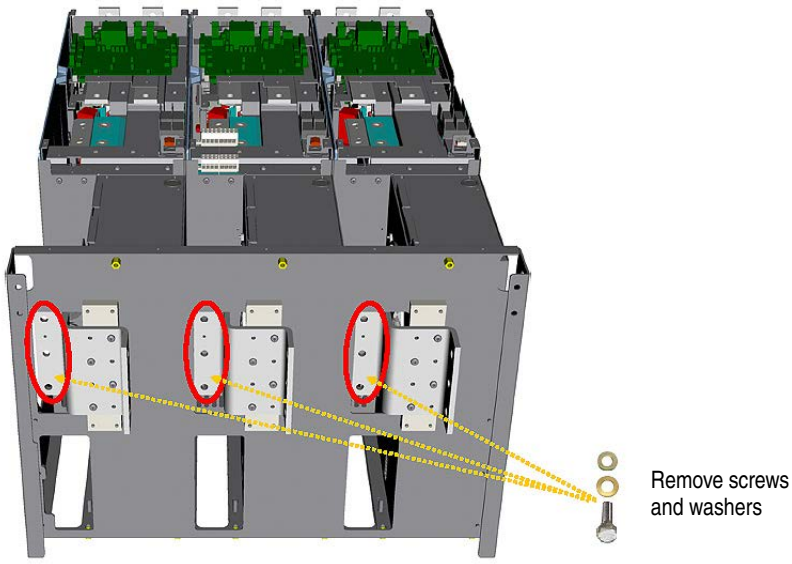
1. Remove the power structure from the AFE enclosure.

See Removing the Power Structure from the Enclosure on page 4-19.

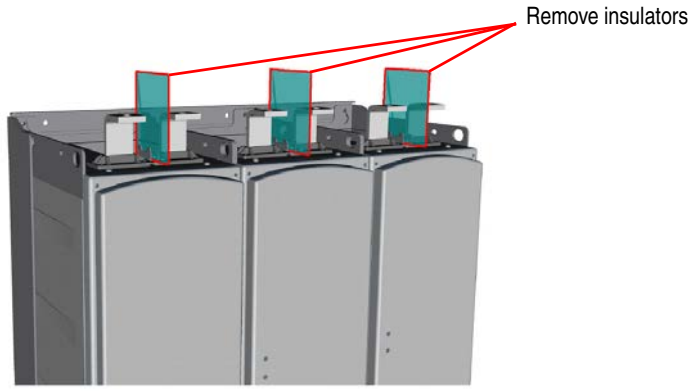
2. Remove the ASIC Circuit board.

See Removing the ASIC Circuit Board on page 4-15.

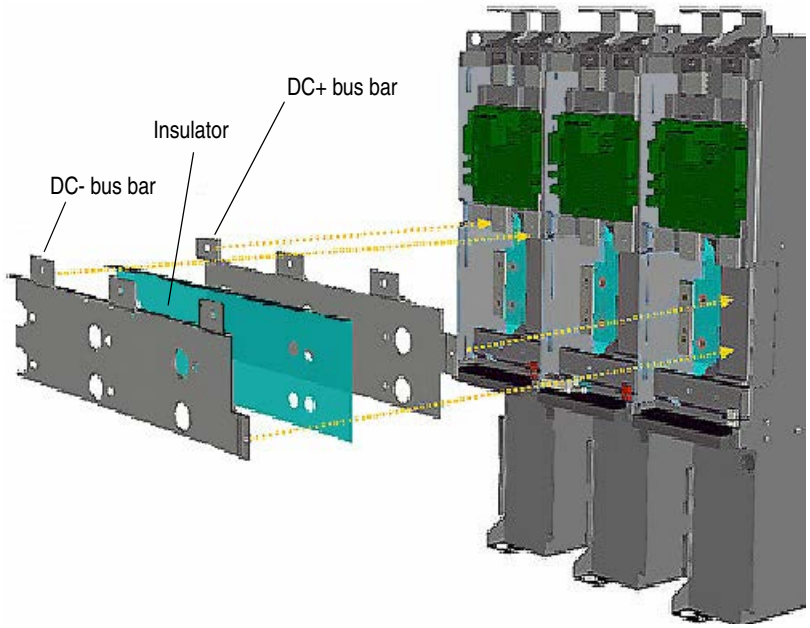
3. Remove the M10 x 25 hexagonal screws that secure the input power cables to the Input Power terminals on the power structure.



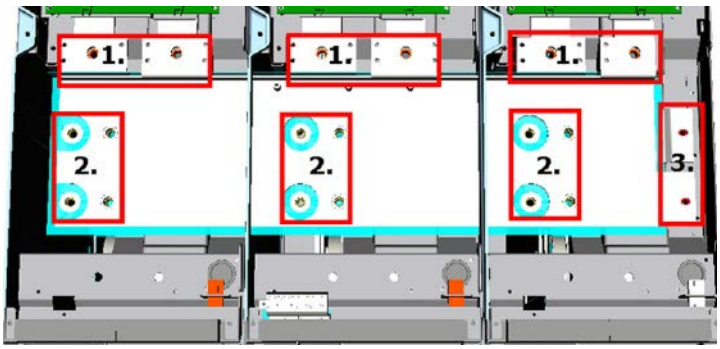
4. Remove the insulators from between the DC+ and DC- bus bars.



5. Remove the M6 x 12 screws that secure the Connective DC Bus Bars and insulators to the Phase Assembly.

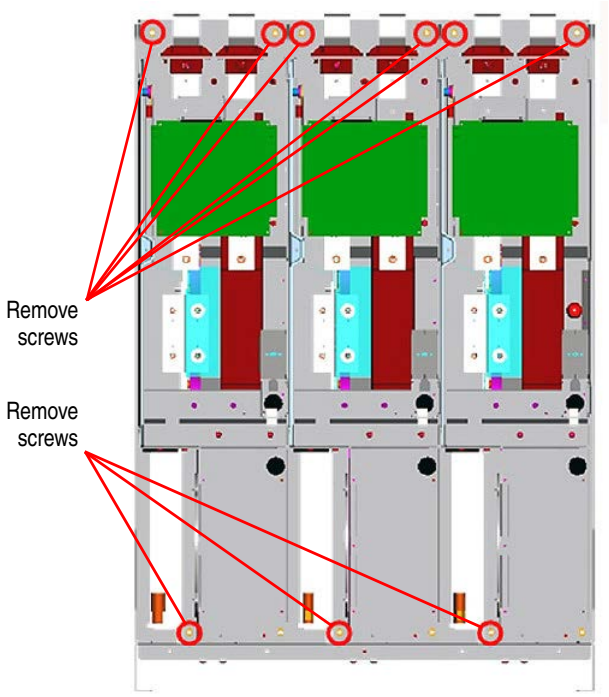


Location	Fasteners	Qty	Torque
1.	M10 x 20 hexagonal screws, M10 spring washers and M10 washers	6	8 N•m (70 lb•in)
2.	M8 x 25 hexagonal screws, M8 spring washers and M8 washers	6	8 N•m (70 lb•in)
3.	M6 x 12 screws	2	4 N•m (35 lb•in)



6. Remove the three M8 x 20 hexagonal screws from the top section of each Phase Assembly (U, V, or W) that you want to remove.

   Note that only two screws are shown for each Phase Assembly in the top section of the drawing.



7. Remove three M8 x 20 hexagonal screws from the bottom section of each Phase Assembly (U, V, or W) that you want to remove.

   Note that only one screw is shown for each Phase Assembly in the bottom section of the drawing.

8. Disconnect the three input power cables from the lower section of the Phase Assembly that you want to remove.

9. Remove the Phase Assembly by using appropriate lifting equipment.

Removing the Power Module from the U, V, or W Phase Assembly

Important: Do not attempt to disassemble the Power Module within the U, V, or W Phase Assembly.

Important: When replacing a damaged Power Module, it is recommended to replace all three Power Modules to avoid potential failure on the remaining Power Modules due to residual damage.

The following procedure describes removing the Power Module from one Phase Assembly. Repeat this procedure for each Phase Assembly.

1. Remove the power structure from the AFE enclosure.

   See Removing the Power Structure from the Enclosure on page 4-19.

2. Remove the U, V, or W Phase Assembly from the power structure.

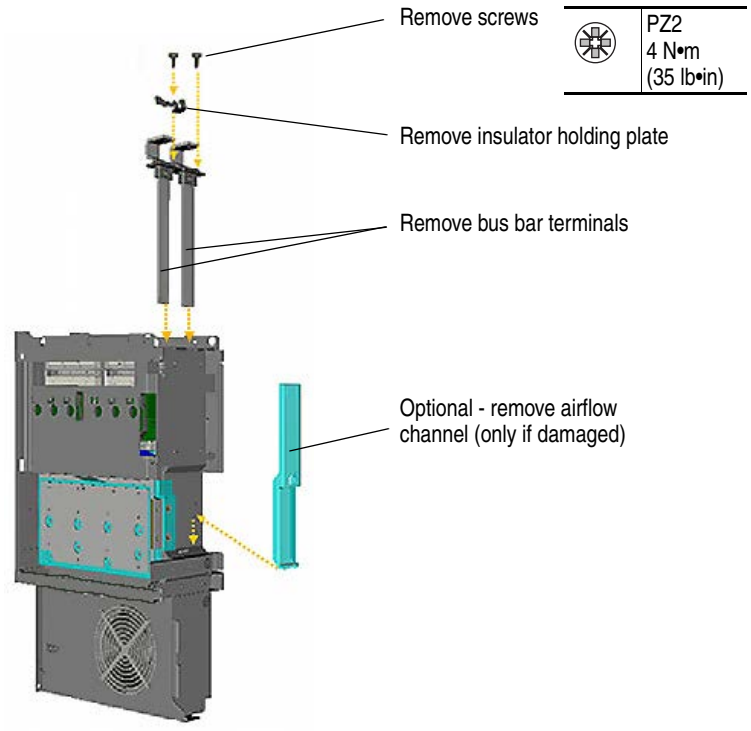
   See Removing the U, V, or W Phase Assembly from the Power Structure on page 4-23.

3. Remove the insulator holding plate from between the bus bar terminals.

4. Remove the M5 POZIDRIV screws that secure the bus bar terminals to the power structure.

5. Slide the bus bar terminals out of the Phase Assembly.

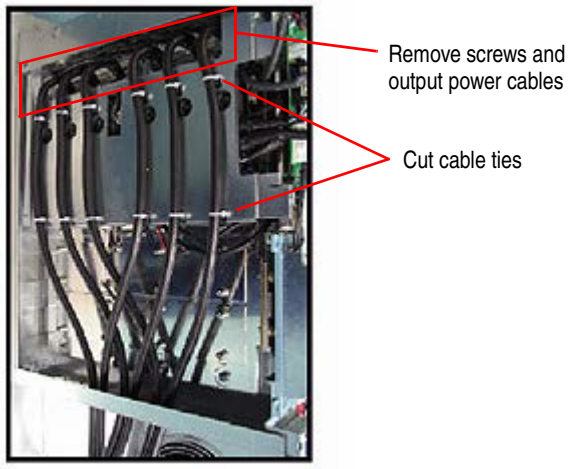
6. If the bus bar Airflow Channel is damaged, remove and replace it.



7. Remove the M8 x 20 hexagonal screws that secure the input power cables to the input power bus bar.

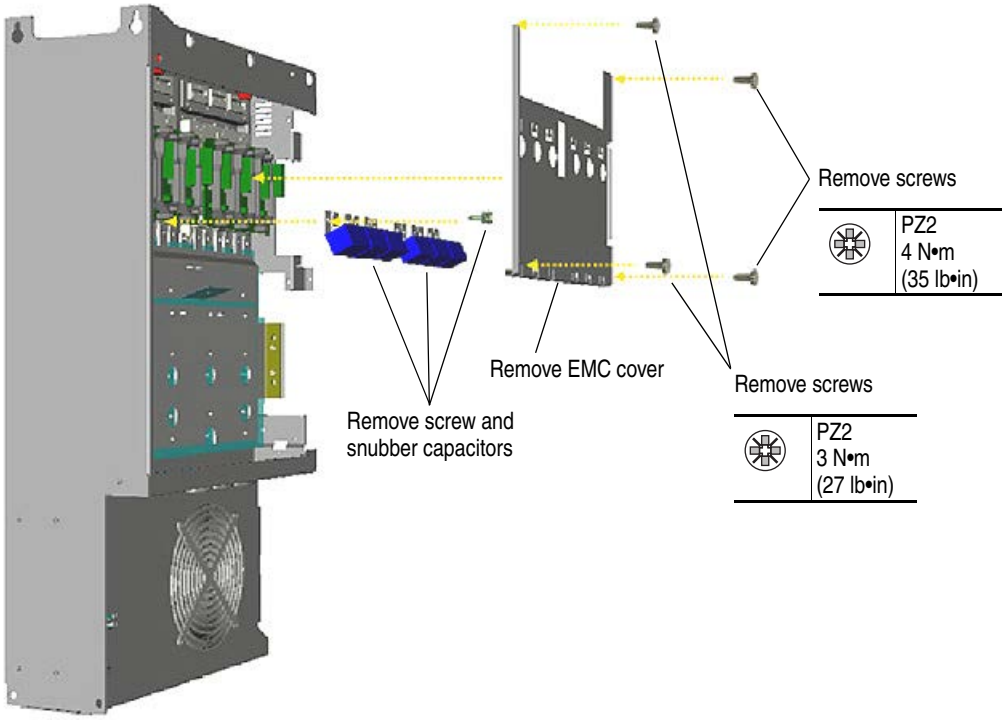
   Tightening torque for reassembly is 14 N•m (124 lb•in).

8. Cut and remove the cable ties that secure the input power cables to the EMC cover plate and remove the cables.



9. Remove the M5 x 10 POZIDRIV and M4 x 8 POZIDRIV screws that secure the EMC cover to the AFE, and remove the cover.

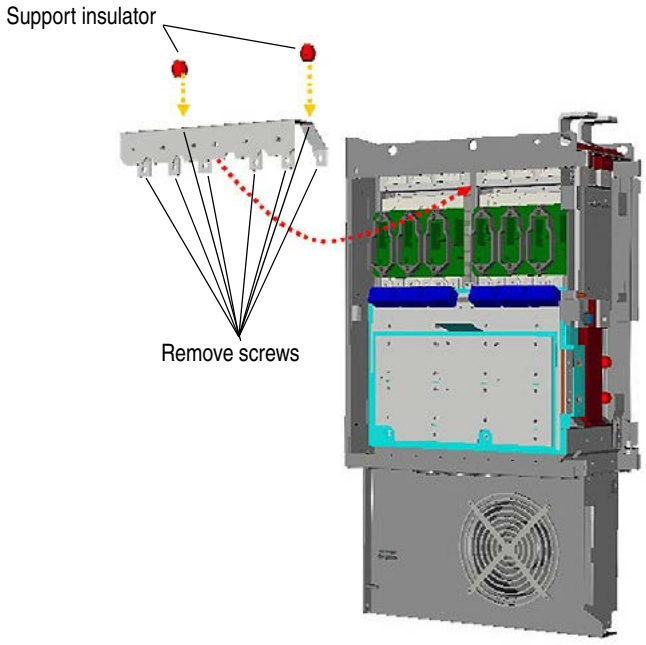
10. Remove the screws that secure the Snubber Capacitors to the U, V, or W Phase Assembly, and remove the Snubber Capacitors.



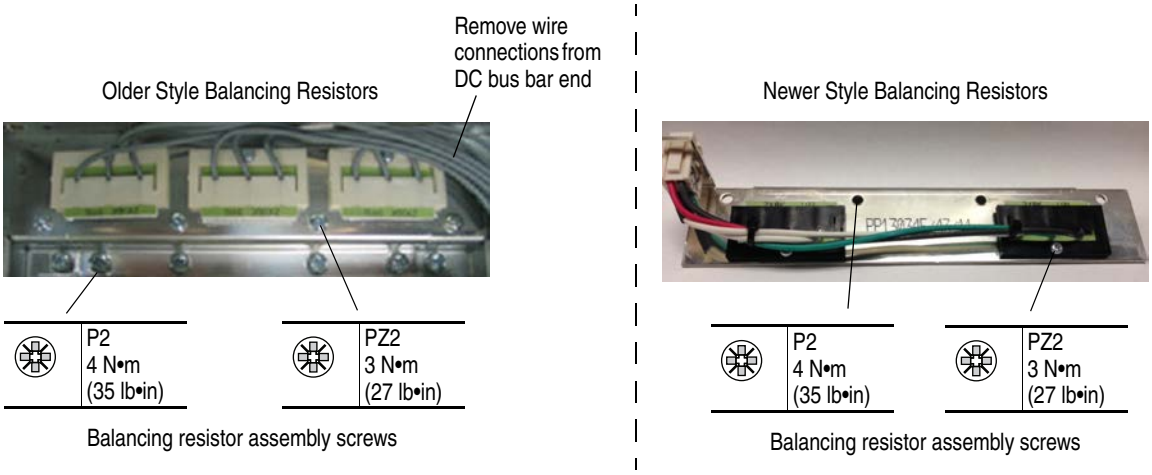
11. Remove the screws that secure the Power Bus Bar and support insulators to the power structure.

12. Remove the Power Bus Bar and insulators.

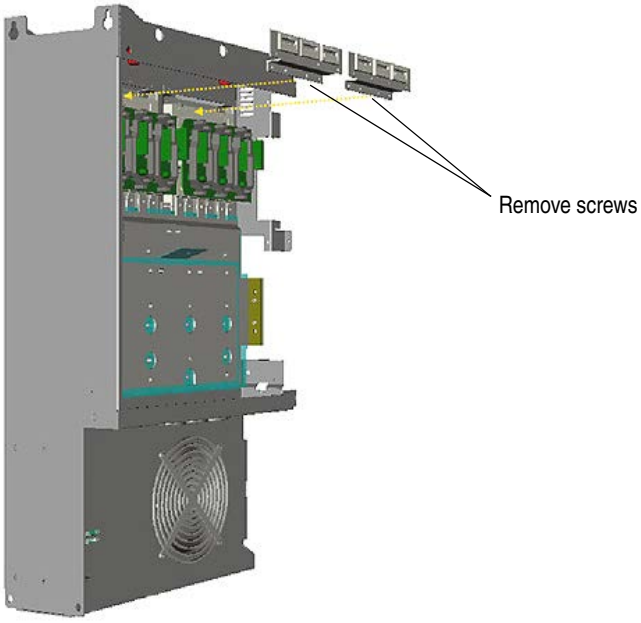
Tightening torque for reassembly is 14 N•m (124 lb•in).



13. Disconnect the Balancing Resistor wires from the DC bus bars.



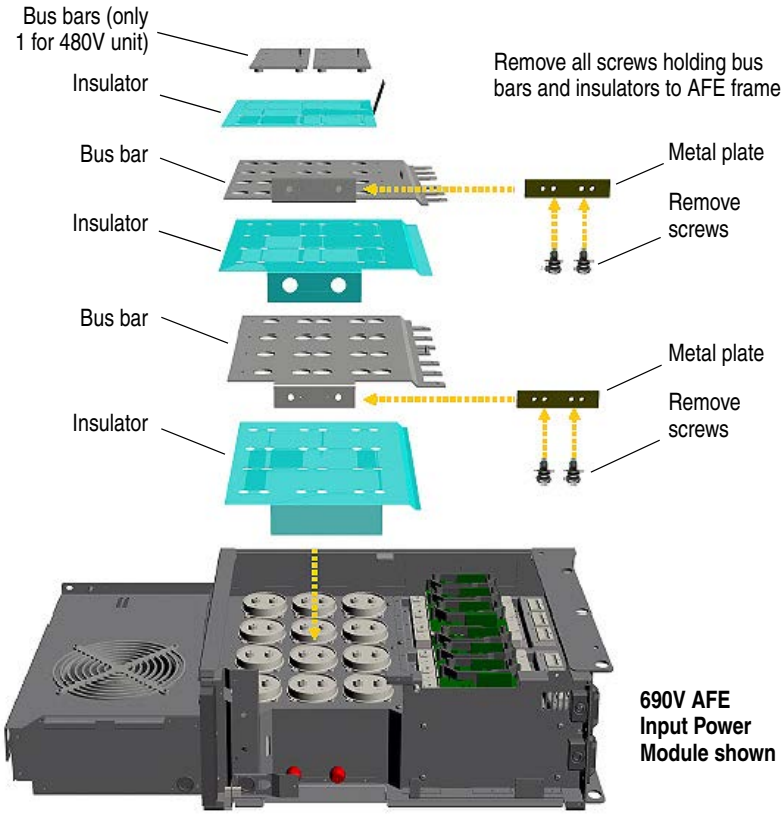
14. Remove the screws that secure the Balancing Resistor assemblies to the U, V, or W Phase Assembly.



15. Remove the Balancing Resistor assemblies (see step 13 picture for screw locations).

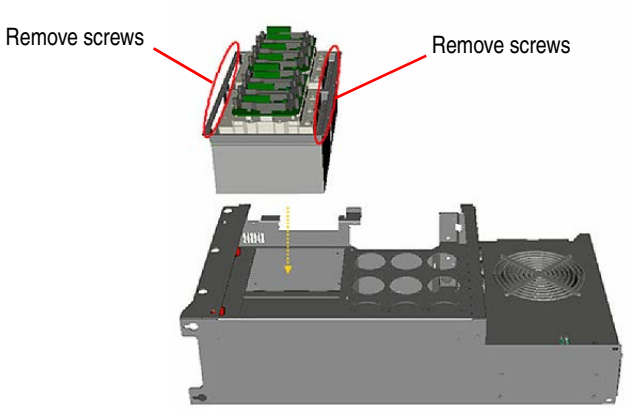
16. Remove the Connective DC Bus Bars and insulators.

Tightening torque for reassembly is 4 N•m (35 lb•in).



17. Remove the M4 x 8 screws that secure the Power Module to the U, V, or W Phase Assembly.

18. Remove the Power Module.



19. Repeat steps 10 through 18 for each remaining Phase Assembly.

Installing the Power Module on the U, V, or W Phase Assembly

Install the Power Module in reverse order of removal, while referring to Torque Specifications on page 4-2.

Removing the U, V, or W Phase Assembly DC Bus Capacitors

1. Remove the power structure from the AFE enclosure.

   See Removing the Power Structure from the Enclosure on page 4-19.

2. Remove the U, V, or W Phase Assembly from the AFE.

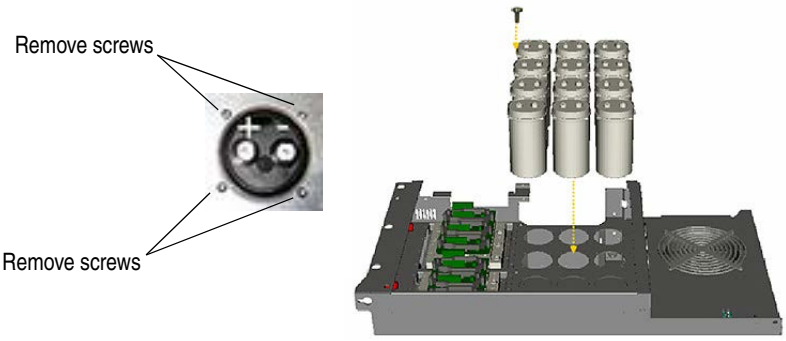
   See Removing the U, V, or W Phase Assembly from the Power Structure on page 4-23.

3. Remove the power module from the U, V, or W Phase Assembly—but do not perform the last three steps (20 through 22) in that procedure.

   See Removing the Power Module from the U, V, or W Phase Assembly on page 4-25.

4. Note the polarity of the capacitors.

5. Remove the four M4 x 8 screws that secure the capacitor to the power structure.



6. Remove the capacitor.

   Tightening torque for reassembly is 1.35 N•m (12 lb•in). We recommend replacing all capacitors at the same time.

7. Repeat steps 5 and 6 for each remaining DC Bus Capacitor being removed.

Installing the U, V, or W Phase Assembly DC Bus Capacitors

Install the capacitors in reverse order of removal. Make sure to observe the polarity of the capacitors as noted in removal step 4 above.

Replacing the Existing Power Structure with a New Power Structure

When replacing the existing AFE Frame 13 power structure with a new one (SK-Y1-PWRMOD-D1K3 for 400/480V or SK-Y1-PWRMOD-E1K0 for 600/690V), you must do the following before installing the new power structure to avoid possible equipment malfunction:

- Remove the common mode capacitors in the **new** power structure.
- Remove the Power Supply Voltage Feedback board from the **new** power structure.

Use the following procedure.

1. Remove the old power structure from the enclosure.

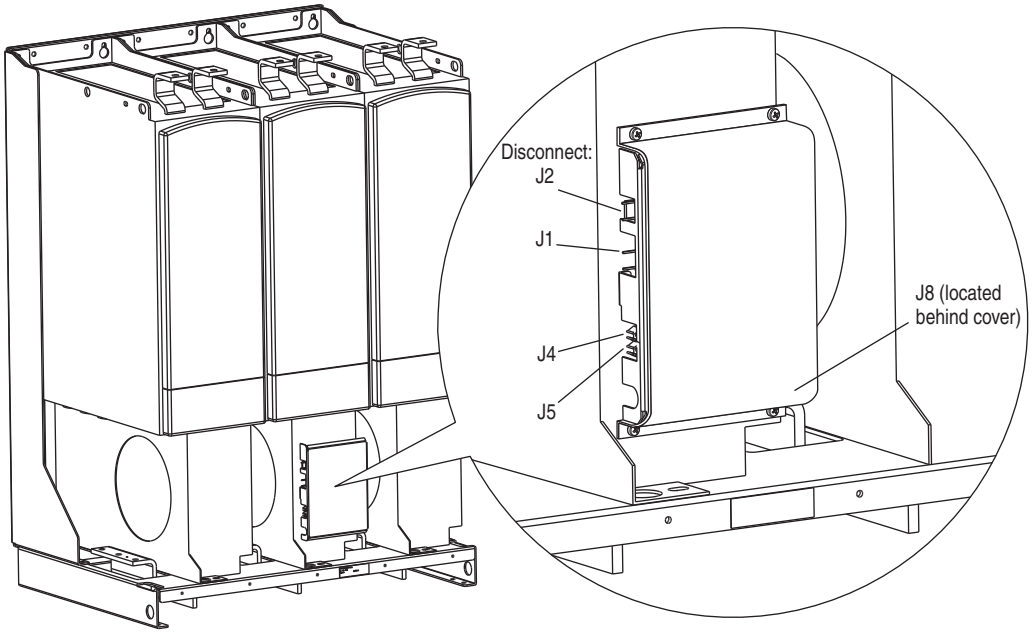
   See Removing the Power Structure from the Enclosure on page 4-19.

2. Remove the common mode capacitors from the new Frame 13 power structure that is replacing the old power structure.

   For the procedure to remove the common mode capacitors, see the PowerFlex Active Front End User Manual, publication 20Y-UM001. Refer to Chapter 2, section ‘Disconnecting Common Mode Capacitors’, and subsection ‘Frame 13 Power Structure’. These instructions apply to an AFE in a IP20 2500MCC Style enclosure or an AFE in a IP21 Rittal enclosure.

3. Use the following substeps to remove the Power Supply Voltage Feedback board from the new Frame 13 power structure that is replacing the old power structure.

   a. Disconnect the DC bus connection cable from connector J2, and the motor feedback connection cable from connector J1 at the top of the Power Supply Voltage Feedback board.



   b. Carefully disconnect the fiber optic cables from sockets J4 and J5 on the side of the Power Supply Voltage Feedback board, and secure these unused cables to the adjacent fan housing so that they are out of the way.

ATTENTION: Hazard of permanent eye damage exists when using optical transmission equipment. This product emits intense light and invisible radiation. Do not look into fiber optic ports or fiber optic cable connectors.

   c. Remove the four screws that secure the Power Supply Voltage Feedback board and cover to the V phase assembly module fan housing.

   d. Carefully remove the Power Supply Voltage Feedback board and cover.

   e. Disconnect the cable from connector J8 on the Power Supply Voltage Feedback board, and secure this unused cable to the adjacent fan housing so that it is out of the way.

4. Install the new (replacement) power structure.

   See Installing the Power Structure in the Enclosure on page 4-23.

AC Line Switchgear Component Section

ATTENTION: To avoid an electric shock hazard, verify that all power to the PowerFlex Active Front End has been removed before performing any servicing or repairs.

ATTENTION: To avoid an electric shock hazard, verify that the voltage on the bus capacitors has discharged completely before servicing. Check the DC bus voltage between the +DC and -DC terminals, between the +DC terminal and the chassis, and between the -DC terminal and the chassis. The voltage must be zero for all three measurements.

ATTENTION: The sheet metal cover and mounting screws on the ASIC Board located on the power structure are energized at (-) DC bus potential high voltage. Risk of electrical shock, injury, or death exists if someone comes into contact with the assembly.

ATTENTION: **Hot** surfaces can cause severe burns. **Do not touch** the heatsink surface during operation of the PowerFlex Active Front End. After disconnecting power allow time for cooling.

ATTENTION: Hazard of permanent eye damage exists when using optical transmission equipment. This product emits intense light and invisible radiation. Do not look into fiber optic ports or fiber optic cable connectors.

ATTENTION: The PowerFlex Active Front End contains electrostatic discharge (ESD) sensitive parts and assemblies that can be damaged if you do not follow ESD control procedures. Static control precautions are required to install, test, service, or repair this assembly. If you are unfamiliar with static control procedures, see Guarding Against Electrostatic Damage, publication 8000-4.5.2, or any other applicable ESD protection handbook.

AFE in IP20 2500 MCC Style Enclosure

For a PowerFlex AFE system in the IP20 2500 MCC Style enclosure, the AC line switchgear components are the input circuit breaker (Q0), AC input fuses (F1.1…F1.3), and input contactor (K1).

The input circuit breaker either connects or disconnects the AFE system to the AC line. The input contactor connects the internal AFE system AC line to the AFE power structure through the LCL filter. The AFE power structure contains the control logic that opens or closes the input contactor.

See the PowerFlex Active Front End User Manual, publication 20Y-UM001, for the AC input fusing and circuit breaker protection recommendations.

AFE in IP21 Rittal Enclosure

For a PowerFlex AFE system in the IP21 Rittal enclosure, the AC line switchgear components are the input disconnect (Q0) and MCCB (Q1).

The input disconnect either connects or disconnects the AFE system to the AC line. The MCCB connects the internal AFE system AC line to the AFE power structure through the LCL filter. The AFE power structure contains the control logic that enables or disables the resettable trip mechanism that is integrated into the MCCB. The trip mechanism controls the MCCB functionality.

See the PowerFlex Active Front End User Manual, publication 20Y-UM001, for the AC input fusing and MCCB protection recommendations.

Precharge Component Section

ATTENTION: To avoid an electric shock hazard, verify that all power to the PowerFlex Active Front End has been removed before performing any servicing or repairs.

ATTENTION: To avoid an electric shock hazard, verify that the voltage on the bus capacitors has discharged completely before servicing. Check the DC bus voltage between the +DC and -DC terminals, between the +DC terminal and the chassis, and between the -DC terminal and the chassis. The voltage must be zero for all three measurements.

ATTENTION: The sheet metal cover and mounting screws on the ASIC Board located on the power structure are energized at (-) DC bus potential high voltage. Risk of electrical shock, injury, or death exists if someone comes into contact with the assembly.

ATTENTION: **Hot** surfaces can cause severe burns. **Do not touch** the heatsink surface during operation of the PowerFlex Active Front End. After disconnecting power allow time for cooling.

ATTENTION: Hazard of permanent eye damage exists when using optical transmission equipment. This product emits intense light and invisible radiation. Do not look into fiber optic ports or fiber optic cable connectors.

ATTENTION: The PowerFlex Active Front End contains electrostatic discharge (ESD) sensitive parts and assemblies that can be damaged if you do not follow ESD control procedures. Static control precautions are required to install, test, service, or repair this assembly. If you are unfamiliar with static control procedures, see Guarding Against Electrostatic Damage, publication 8000-4.5.2, or any other applicable ESD protection handbook.

Precharging Functions

The precharge circuitry has two main functions:

- It provides AFE system enclosure control power.
- It provides the precharge circuitry to charge the DC bus.

The AFE system is available in both 400/480V AC and 600/690V AC system voltage configurations. Control logic voltages are as follows:

- For an AFE in a IP20 2500 MCC Style enclosure, it is 120V AC single phase and also 24V DC power.
- For an AFE in a IP21 Rittal enclosure, it is 230V AC single phase and also 24V DC power.

The precharge circuitry lets the DC capacitors, located in the AFE power structure, to be properly charged with in-line current limiting resistors to DC bus voltage magnitudes.

See the PowerFlex Active Front End User Manual, publication 20Y-UM001, for the minimum and maximum system capacitance requirements.

Replacing the Precharge Fuse

The precharge fuse assembly for an AFE in a IP20 enclosure is located in the Input Power enclosure. For an AFE in a IP21 enclosure, the precharge fuse assembly is located in the Power Structure enclosure.

1. Remove power from the AFE.

   See Removing Power from the AFE on page 4-3.

2. Open the appropriate enclosure door.
3. If present, remove the protective barriers.

   See Removing AFE Protective Barriers on page 4-10.

4. Slide the fuse sleeve out from the fuse holder.
5. Remove the fuse from the sleeve and appropriately discard the old fuse.
6. See the appropriate table below for the recommended new replacement fuse, and install the fuse in reverse order of removal.

Table 6.A 400/480 Volt Precharge Fuse Rating

Frame Size	Enclosure Style	Fuse		Fuse Holder (3)
		Amps	Type	Type
13	IP20 2500 MCC	50	Bussmann DFJ-50 (1)	Bussmann CH60J3
	IP21 Rittal	32	ABB OFAF000H32 (2)	ABB O540D12000

(1) Precharge fuse designation is F5 for AFE in IP20 2500 MCC style enclosure.

(2) Precharge fuse designation is F6 for AFE in IP 21 Rittal enclosure.

(3) Precharge fuse holder holds a quantity of three fuses.

Table 6.B 600/690 Volt Precharge Fuse Rating

Frame Size	Enclosure Style	Fuse		Fuse Holder (3)
		Amps	Type	Type
13	IP20 2500 MCC	50	Bussmann DFJ-50 (1)	Bussmann CH60J3
	IP21 Rittal	32	ABB OFAA000GG32 (2)	ABB O540D12000

(1) Precharge fuse designation is F5 for AFE in IP20 2500 MCC style enclosure.

(2) Precharge fuse designation is F6 for AFE in IP 21 Rittal enclosure.

(3) Fuse holder holds a quantity of three fuses.

Testing the Control Transformer (T4) and 24V DC Power Supply (T10)

For AFE in IP20 2500 MCC Style Enclosure

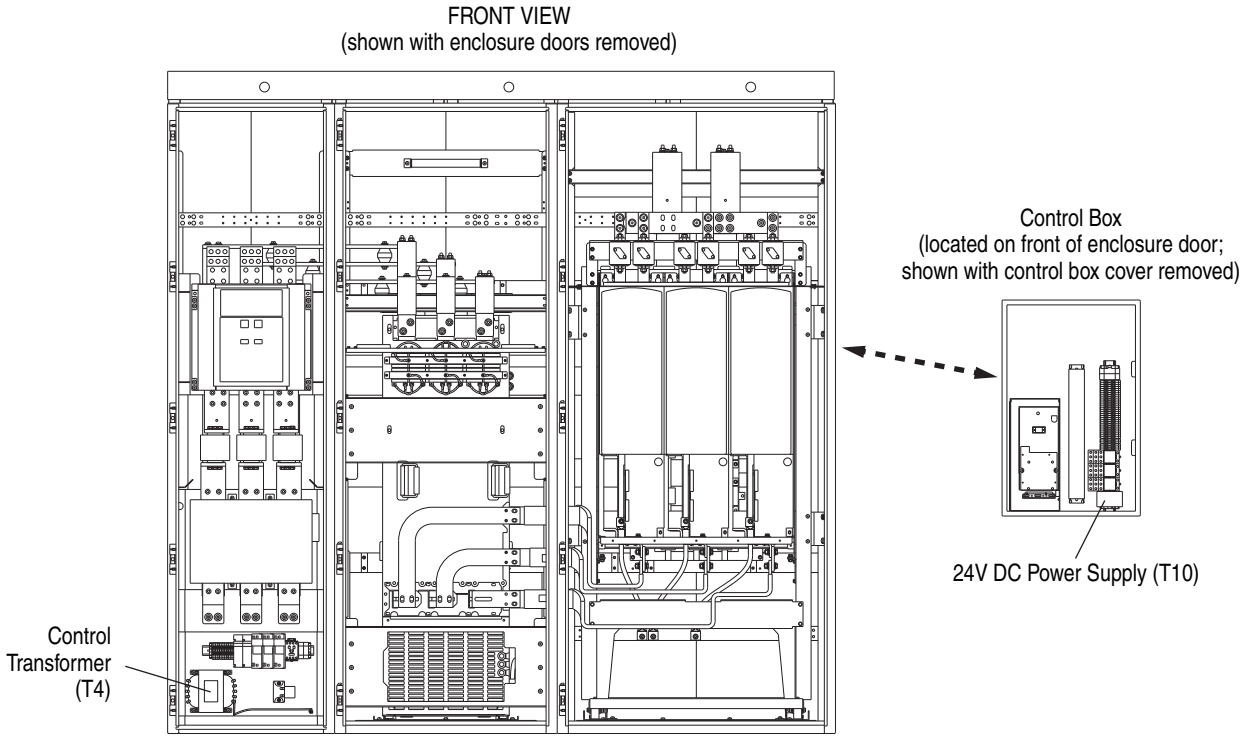
1. If present, remove the protective barriers.

   See Removing AFE Protective Barriers on page 4-10.

ATTENTION: These tests must be performed by qualified personnel. During these tests, the AFE is powered. Take proper precautions to avoid injury from electrical shock.

2. Locate the control transformer (T4) and 24V DC power supply (T10).

   The control transformer (T4) is located at the bottom of the left-most enclosure (AC input switchgear). The 24V DC power supply (T10) is located in the bottom of the control box.



3. Use a digital voltmeter to test the control transformer (T4).

   a. Measure the primary AC line voltage, which is at the 400…480V AC or 600…690V AC system voltage.

   b. Measure the control transformer (T4) output voltage, which is approximately 120V AC.

   If these measurements are not within ±10%, perform these other steps.

   c. Power down the AFE.

   d. Remove the output (secondary) wires.

   e. Power up the AFE and retest by repeating steps a and b.

   The control transformer (T4) may require replacement if these measurements continue to be outside of the ±10% tolerance.

4. Use a digital voltmeter to test the 24V DC power supply (T10).

   a. Measure the primary voltage, which is 120V AC.

   b. Measure the power supply (T10) output voltage, which is approximately 24V DC.

   If these measurements are not within ±10%, perform these other steps.

   c. Power down the AFE.

   d. Remove the 24V DC output wires of the power supply (T10).

   e. Power up the AFE and retest by repeating steps a and b.

   The 24V DC power supply (T10) may require replacement if these measurements continue to be outside of the ±10% tolerance.

For AFE in IP21 Rittal Enclosure

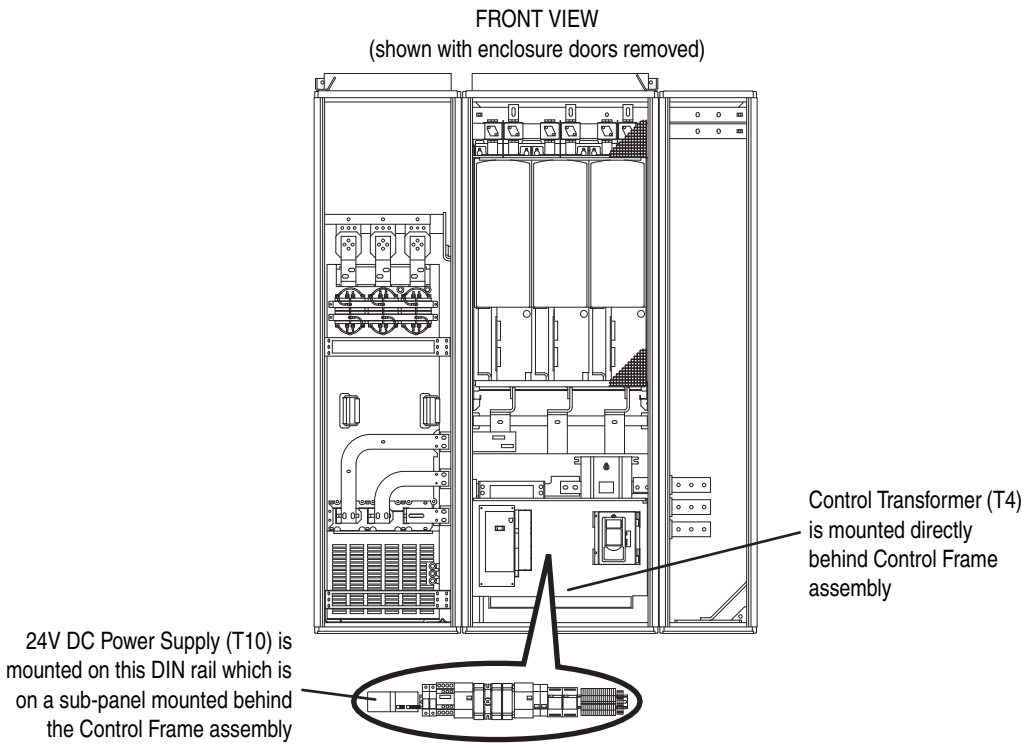
1. If present, remove the protective barriers.

   See Removing AFE Protective Barriers on page 4-10.

ATTENTION: These tests must be performed by qualified personnel. During these tests, the AFE is powered. Take proper precautions to avoid injury from electrical shock.

2. Locate the control transformer (T4) and 24V DC power supply (T10).

   The control transformer (T4) is located behind the Control Frame. The 24V DC power supply (T10) is located on a sub-panel in front of the components shown in the front view.


FRONT VIEW
(shown with enclosure doors removed)
Control Transformer (T4) is mounted directly behind Control Frame assembly
24V DC Power Supply (T10) is mounted on this DIN rail which is on a sub-panel mounted behind the Control Frame assembly

3. Use a digital voltmeter to test the control transformer (T4).

a. Measure the primary AC line voltage, which is at the 400…480V AC or 600…690V AC system voltage.

b. Measure the control transformer (T4) output voltage, which is approximately 230V AC.

If these measurements are not within ±10%, perform these other steps.

c. Power down the AFE.

d. Remove the output (secondary) wires.

e. Power up the AFE and retest by repeating steps a and b.

The control transformer (T4) may require replacement if these measurements continue to be outside of the ±10% tolerance.

4. Use a digital voltmeter to test the 24V DC power supply (T10).

a. Measure the primary voltage, which is 230V AC.

b. Measure the power supply (T10) output voltage, which is approximately 24V DC.

If these measurements are not within ±10%, perform these other steps.

c. Power down the AFE.

d. Remove the 24V DC output wires of the power supply (T10).

e. Power up the AFE and retest by repeating steps a and b.

The 24V DC power supply (T10) may require replacement if these measurements continue to be outside of the ±10% tolerance.

Testing the Precharge Bridge Using the Power Structure Terminals

1. Remove power from the AFE.

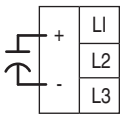
   See Removing Power from the AFE on page 4-3.

2. If present, remove the protective barriers.

   See Removing AFE Protective Barriers on page 4-10.

3. To test the precharge bridge, measure the points on the power structure listed in the table below.

Table 6.C Precharge Bridge Tests on Power Structure

Meter Leads		Nominal Meter Reading	Test Point Locations
+	-		
DC-	L1	Value should gradually rise to about 0.48V (1)	
DC-	L2		
DC-	L3		
L1	DC+		
L2	DC+		
L3	DC+		
L1	DC-	Meter should display charging voltage	
L2	DC-		
L3	DC-		
DC+	L1		
DC+	L2		
DC+	L3		

(1) The actual voltage reading can vary depending upon your equipment. If your readings are not near 0.48V, verify that the actual voltage measured is consistent for the power structure.

Replacing the Precharge Bridge

1. Remove power from the AFE.

   See Removing Power from the AFE on page 4-3.

2. Open the power structure enclosure door.

3. If present, remove the protective barriers.

   See Removing AFE Protective Barriers on page 4-10.

4. Remove the protective front covers and terminal covers from the power structure.

   See Removing Protective Covers from the Power Structure on page 4-13.

5. Remove the four POZIDRIVE screws that secure the bridge protective cover.

6. Remove the bridge protective cover.

7. Prior to removal, note the locations of the DC+, DC–, L1, L2, and L3 wires, and then disconnect these wires.

8. Remove the precharge bridge mounting nuts.
9. Remove and appropriately discard the old precharge bridge.
10. Install the new precharge bridge in reverse order of removal, while referring to Torque Specifications on page 4-2.

Testing the Precharge Resistor

1. Remove power from the AFE.

   See Removing Power from the AFE on page 4-3.

2. Open the LCL Filter enclosure door.
3. If present, remove the protective barriers.

   See Removing AFE Protective Barriers on page 4-10.

4. Measure the resistance between the following two points with an ohmmeter:

   – Between the (+) side of the precharge resistor R6.1 and the (+) terminal on the TB of the precharge circuit.
   NOTE: This measurement applies to an AFE in either a IP20 2500 MCC Style enclosure or an AFE in a IP21 Rittal enclosure.

   – Between the (–) side of the precharge resistor R6.2 and the (–) terminal on the TB of the precharge circuit.
   NOTE: This measurement only applies to an AFE in a IP21 Rittal enclosure.

   The precharge resistance is approximately 11 ohms for each measurement for an AFE in a IP20 2500 MCC Style enclosure, or 20 ohms for each measurement for an AFE in a IP21 Rittal enclosure. If the measured value is not correct, disconnect a resistor wire and re-measure again. If the measured value is still not correct, replace the precharge resistor.

   Important: Verify that the precharge resistor has not been engineered to a different value by the system engineer to accommodate a larger system capacitance, as this may change the value of the precharge resistor. See the PowerFlex Active Front End User Manual, publication 20Y-UM001, for total DC bus capacitance limits for the precharging circuit.

Replacing the Precharge Resistor Assembly

AFE in IP20 2500 MCC Style Enclosure

1. Remove power from the AFE.

   See Removing Power from the AFE on page 4-3.

2. Open the LCL Filter enclosure door.

3. If present, remove the protective barriers.

   See Removing AFE Protective Barriers on page 4-10.

4. Disconnect the R6.1 precharge resistor wires from the resistor terminals on the precharge resistor assembly.

5. Remove the two precharge resistor assembly mounting screws that secure the assembly to the bracket on the LCL enclosure bay.

6. Remove the mounting screws from the failed precharge resistor, and appropriately discard the resistor.

7. Install the new precharge resistor in reverse order of removal, while referring to Torque Specifications on page 4-2.

AFE in IP21 Rittal Enclosure

1. Remove power from the AFE.

   See Removing Power from the AFE on page 4-3.

2. Open the LCL Filter enclosure door.

3. If present, remove the protective barriers.

   See Removing AFE Protective Barriers on page 4-10.

4. Disconnect the wires from the (+) and (-) terminals on the precharge resistor assembly.

5. Verify that the capacitor on the bridge (+) and (-) terminals is still in the circuit.

6. Disconnect the white wires from the terminal block by the bridge.

7. Remove the mounting screws from the failed precharge resistor, and appropriately discard the resistor.

8. Install the new precharge resistor in reverse order of removal, while referring to Torque Specifications on page 4-2.

LCL Filter Component Section

ATTENTION: To avoid an electric shock hazard, verify that all power to the PowerFlex Active Front End has been removed before performing any servicing or repairs.

ATTENTION: To avoid an electric shock hazard, verify that the voltage on the bus capacitors has discharged completely before servicing. Check the DC bus voltage between the +DC and -DC terminals, between the +DC terminal and the chassis, and between the -DC terminal and the chassis. The voltage must be zero for all three measurements.

ATTENTION: The sheet metal cover and mounting screws on the ASIC Board located on the power structure are energized at (-) DC bus potential high voltage. Risk of electrical shock, injury, or death exists if someone comes into contact with the assembly.

ATTENTION: **Hot** surfaces can cause severe burns. **Do not touch** the heatsink surface during operation of the PowerFlex Active Front End. After disconnecting power allow time for cooling.

ATTENTION: Hazard of permanent eye damage exists when using optical transmission equipment. This product emits intense light and invisible radiation. Do not look into fiber optic ports or fiber optic cable connectors.

ATTENTION: The PowerFlex Active Front End contains electrostatic discharge (ESD) sensitive parts and assemblies that can be damaged if you do not follow ESD control procedures. Static control precautions are required to install, test, service, or repair this assembly. If you are unfamiliar with static control procedures, see Guarding Against Electrostatic Damage, publication 8000-4.5.2, or any other applicable ESD protection handbook.

Removing the LCL Filter Protective Barriers and Vented Cover

1. Remove power from the AFE.

   See Removing Power from the AFE on page 4-3.

2. Remove the protective barriers from the LCL Filter enclosure.

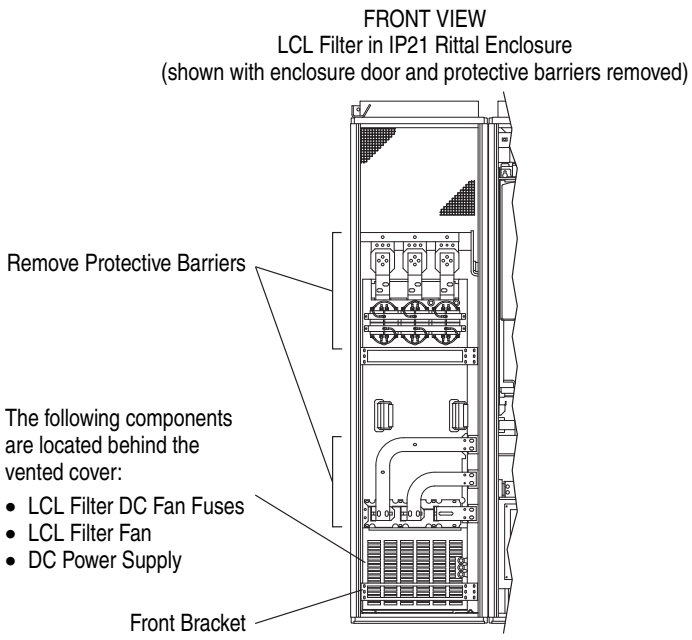
   For an AFE in a IP20 MCC Style enclosure, see Removing AFE Protective Barriers on page 4-10. For an AFE in a IP21 Rittal enclosure, see Figure 7.1 below.

3. Remove the four T25 Torx self-tapping screws that secure the front bracket shown in the figure below.

   This bracket holds the LCL Filter in the enclosure.

4. Remove the vented cover from the bottom of the LCL Filter to access the DC fan fuses, fan, and DC power supply.

Figure 7.1 Removing Protective Barriers and Vented Cover from LCL Filter


FRONT VIEW
LCL Filter in IP21 Rittal Enclosure
(shown with enclosure door and protective barriers removed)
Remove Protective Barriers
The following components are located behind the vented cover:
• LCL Filter DC Fan Fuses
• LCL Filter Fan
• DC Power Supply
Front Bracket

Installing the LCL Filter Protective Barriers and Vented Cover

Reinstall the protective barriers and vented cover in reverse order of removal, while referring to Torque Specifications on page 4-2.

Replacing the LCL Filter DC Fan Fuses

The LCL Filter DC fan fuses are located behind the vented cover at the bottom of the LCL Filter.

Important: Replace LCL Filter fan fuses with only ATQ8 (Ferraz Shawmut) fuses.

For complete details on LCL fan system information, see PowerFlex 700H, 700S, and 700AFE Drive Fan Systems Installation Instructions, publication PFLEX-IN029.

Removing the LCL Filter Fan DC Power Supply

The following figures show the LCL Filter fan DC Power Supply wiring diagram with the connections to the AFE power structure and DC bus.

For complete details on LCL fan system information, see the PowerFlex 700H, 700S, and 700AFE Drive Fan Systems Installation Instructions, publication PFLEX-IN029.

Figure 7.2 LCL Filter Fan DC Power Supply Wiring Diagram (older version)

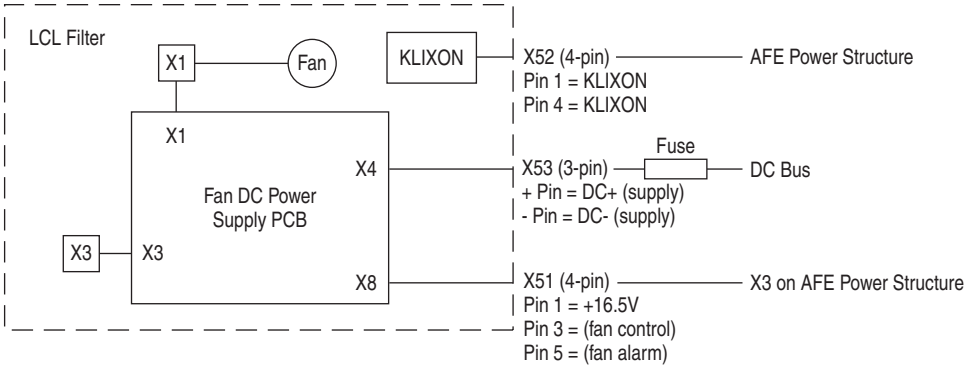
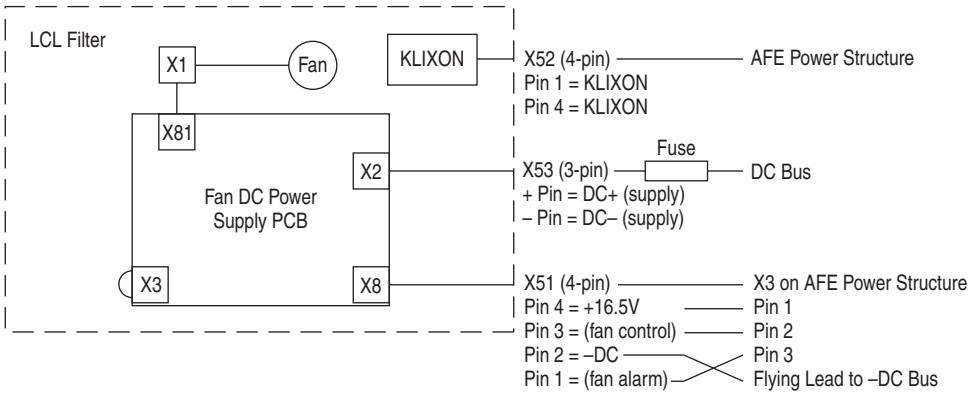
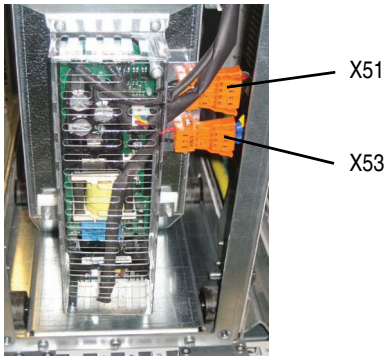


Figure 7.3 LCL Filter Fan DC Power Supply Wiring Diagram (newer version)



Important: Before doing any work, disconnect the AFE power structure from the AC supply, and wait until the fan stops and the indicators on the keypad turn off. (If a keypad is not attached, see the indicator through the keypad base.) Wait 5 more minutes before doing any work on the DC-to-DC power supply to let it completely discharge. Furthermore, do not open the cover until after this time has expired.



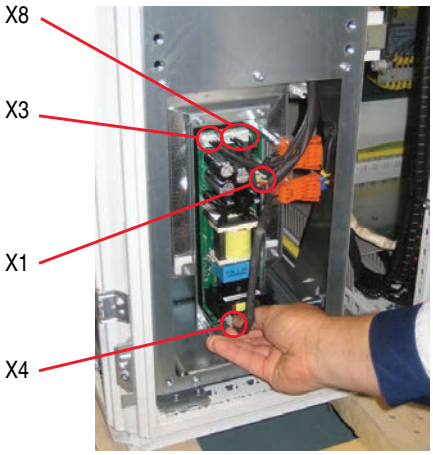
1. Remove the LCL Filter protective barriers.

   See Removing the LCL Filter Protective Barriers and Vented Cover on page 7-2.

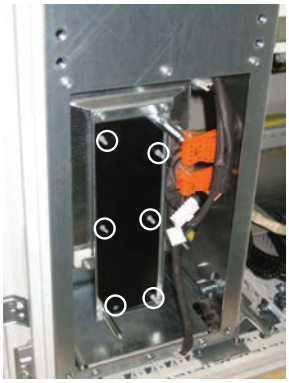
2. Remove the two M4 x 10 mm POZIDRIVE screws that secure the cover.

3. Remove the cover.

4. Remove the connectors X1, X3, X4, and X8.



5. Remove the six fasteners that secure the DC-to-DC power supply.



Installing the LCL Filter Fan DC Power Supply

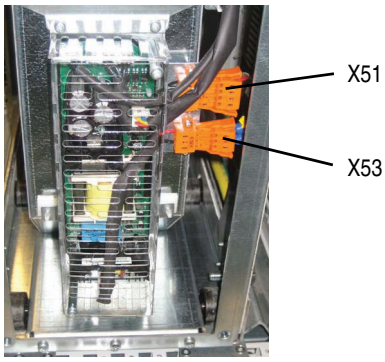
Install the DC-to-DC power supply in reverse order of removal, while referring to Torque Specifications on page 4-2.

Replacing the LCL Filter Fan

1. Remove the LCL Filter protective barriers.

   See Removing the LCL Filter Protective Barriers and Vented Cover on page 7-2.

2. Disconnect terminal blocks X51 and X53.



3. Lower the front fan sheet metal edge and slide it forward to remove the alignment studs from their respective holes in the fan frame sheet metal.
4. Slide out the fan assembly.
5. Remove the LCL Filter Fan DC Power supply.

   See Removing the LCL Filter Fan DC Power Supply on page 7-3.

6. Reinstall the LCL Filter Fan in reverse order of removal, while referring to Torque Specifications on page 4-2.

   Note the following LCL Filter air flow cooling requirements.

LCL FIlter	Required Air Flow
LCL 460	1100 m^3/hr
LCL 1300	1300 m^3/hr

Removing the LCL Filter

The procedures to remove the LCL Filter are slightly different depending on the enclosure in which it is installed.

From the IP20 2500 MCC Style Enclosure

1. Remove power from the AFE.

   See Removing Power from the AFE on page 4-3.

2. Remove the LCL Filter protective barriers.

   See Removing the LCL Filter Protective Barriers and Vented Cover on page 7-2.

3. Remove the Air Flow Plate.

   See Removing the AFE Air Flow Plate on page 4-12.

4. Remove the X51 and X53 terminal blocks from the LCL fan assembly.

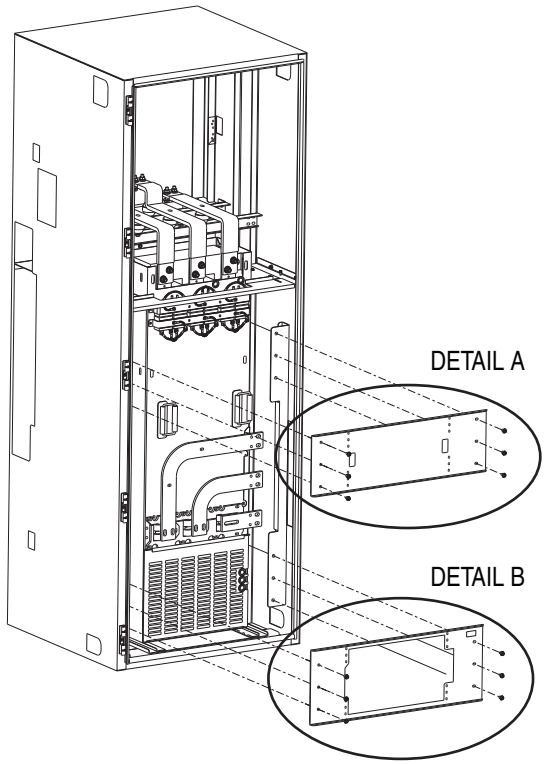
5. Remove the X52 terminal block from the LCL filter assembly (upper right side).

6. Remove the top and bottom brackets that hold the LCL Filter in the enclosure (see Figure 7.4).

   a. See Detail A and remove the six M8 x 20 screws.

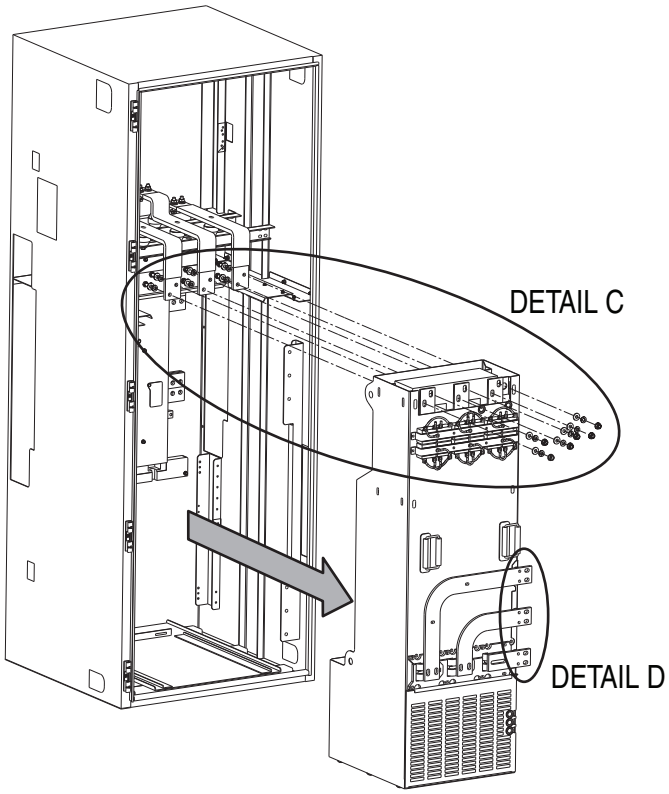
   b. See Detail B and remove the six M8 x 20 screws.

Figure 7.4 Removing LCL Filter from AFE in IP20 2500 MCC Style Enclosure



7. See Figure 7.5, Detail C and remove the six M10 x 10 washer hex nuts and associated hardware that secure the input bus bars to the LCL Filter.

Figure 7.5 Removing Input Bus Bar Connections



8. See Figure 7.5, Detail D and remove the twelve M6 x16 screws that secure the LCL Filter output bus bars to the AFE power structure.

9. See Figure 7.5 and slide the LCL Filter out of the enclosure.

ATTENTION: The LCL Filter is heavy. To avoid personal injury or damage to the equipment, use caution when removing the LCL Filter from the enclosure.

Note that ramps may be required due to enclosure floor mismatch.

From the IP21 Rittal Enclosure

1. Remove power from the AFE.

   See Removing Power from the AFE on page 4-3.

2. Remove the LCL Filter protective barriers.

   See Removing the LCL Filter Protective Barriers and Vented Cover on page 7-2.

3. Remove the X51 and X53 terminal blocks from the LCL fan assembly.

4. Remove the X52 terminal block from the LCL filter assembly (upper right side).
5. Remove the four T25 Torx self-tapping screws that secure the front bracket shown in Figure 7.1.

   This bracket holds the LCL Filter in the enclosure.
6. Remove the MCCB-to-LCL Filter bus bars (L1, L2, L3).

   For bus bar locations, see Figure 2.6 on page 2-6.
7. Remove the LCL Filter-to-AFE power structure bus bars (U, V, W).

   For bus bar locations, see Figure 2.6 on page 2-6.
8. Disconnect the ground wire from the LCL Filter chassis.

ATTENTION: The LCL Filter is heavy. To avoid personal injury or damage to the equipment, use caution when removing the LCL Filter from the enclosure.

9. Slide the LCL Filter out of the enclosure.

   Note that ramps may be required due to enclosure floor mismatch.

Installing the LCL Filter in the Enclosure

Install the LCL Filter in reverse order of removal, while referring to Torque Specifications on page 4-2.

DC Fuses Component Section

ATTENTION: To avoid an electric shock hazard, verify that all power to the PowerFlex Active Front End has been removed before performing any servicing or repairs.

ATTENTION: To avoid an electric shock hazard, verify that the voltage on the bus capacitors has discharged completely before servicing. Check the DC bus voltage between the +DC and -DC terminals, between the +DC terminal and the chassis, and between the -DC terminal and the chassis. The voltage must be zero for all three measurements.

ATTENTION: The sheet metal cover and mounting screws on the ASIC Board located on the power structure are energized at (-) DC bus potential high voltage. Risk of electrical shock, injury, or death exists if someone comes into contact with the assembly.

ATTENTION: **Hot** surfaces can cause severe burns. **Do not touch** the heatsink surface during operation of the PowerFlex Active Front End. After disconnecting power allow time for cooling.

ATTENTION: Hazard of permanent eye damage exists when using optical transmission equipment. This product emits intense light and invisible radiation. Do not look into fiber optic ports or fiber optic cable connectors.

ATTENTION: The PowerFlex Active Front End contains electrostatic discharge (ESD) sensitive parts and assemblies that can be damaged if you do not follow ESD control procedures. Static control precautions are required to install, test, service, or repair this assembly. If you are unfamiliar with static control procedures, see Guarding Against Electrostatic Damage, publication 8000-4.5.2, or any other applicable ESD protection handbook.

Overview

An AFE system in a IP20 2500 MCC Style enclosure or IP21 Rittal enclosure contains the protective DC bus fuses.

Important: For PowerFlex AFE systems in the IP00 Open Chassis configuration, output fuses must be supplied by the user.

See the PowerFlex Active Front End User Manual, publication 20Y-UM001, for the DC bus output fusing recommendations.

Fuse Replacement Guidelines

DC bus fuses are required for short circuit protection. The following tables list the recommended DC bus fuses.

Table 8.A 400/480 Volt DC Fusing

Frame Size	AFE Enclosure Style	Fuse		
		Amps	Bussman Type	Ferraz Shawmut Type
13	IP20 2500 MCC	1100	170M6499	—
	IP21 Rittal	1100	—	PC73UD95V11CTF
		1250	170M6566	—

Table 8.B 600/690 Volt DC Fusing

Frame Size	AFE Enclosure Style	Fuse		
		Amps	Bussman Type	Ferraz Shawmut Type
13	IP20 2500 MCC	630	170M6454	—
	IP21 Rittal	630	—	PC73UD13C630TF
		700	170M6305	—

To replace fuses, use the following procedure.

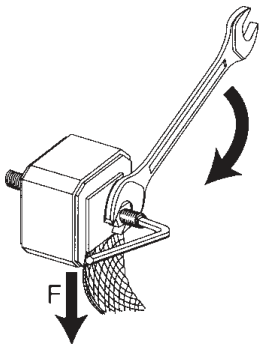
1. Remove power from the AFE.

   See Removing Power from the AFE on page 4-3.

2. Open the power structure enclosure door.
3. If present, remove the protective barriers.

   See Removing AFE Protective Barriers on page 4-10.

4. Remove and discard the blown fuse.
5. Insert the fuse body between the bus bars.
6. Turn the threaded rod into the fuse body.
7. Place the Belleville (domed) washer and hexagonal nut on the threaded rod and hand tighten.
8. Hold the threaded rod with the hex key while tightening the nut to the specified torque.



Stud Type	Stud Tightening Torque, max	Nut Tightening Torque, max
M8 x 30 M8 x 35	10 N•m (88.5 lb•in)	13.5 N•m (132.8 lb•in)
M10 x 30 M10 x 50	15 N•m (132.8 lb•in)	26 N•m (230.1 lb•in)
M12 x 35 M12 x 50	15 N•m (132.8 lb•in)	46 N•m (407.1 lb•in)
M12 x 40	15 N•m (132.8 lb•in)	46 N•m (407.1 lb•in)

Important: Do not apply torque or twisting force to the fuse body, as this can damage the fuse.

For more information about Bussmann fuses, go online at http://www.cooperindustries.com.

For more information about Ferraz Shawmut fuses, go online at http://www.ferrazfuses.com.

Notes:

Startup After Repair

ATTENTION: The sheet metal cover and mounting screws on the ASIC Board located on the power structure are energized at (-) DC bus potential high voltage. Risk of electrical shock, injury, or death exists if someone comes into contact with the assembly.

ATTENTION: Power must be applied to the PowerFlex Active Front End to perform the following start-up procedure. Some of the voltages present are at incoming line potential. To avoid electric shock hazard or damage to equipment, only qualified service personnel should perform the following procedure. Thoroughly read and understand the procedure before beginning. During startup, if one of these pre-powerup checks reveals a concern, **do not proceed**. Remove power including user-supplied control voltages. User-supplied voltages can exist even when main AC power is not applied to the PowerFlex Active Front End. Correct the malfunction before continuing.

Phone	United States/ Canada	1.262.512.8176 (7 AM - 6 PM CST) 1.440.646.5800 (24 hour support)
	Outside United States/Canada	You can access the phone number for your country via the Internet: • Go to http://www.ab.com • Click on *Support* (http://support.rockwellautomation.com/) • Under *Contact Customer Support*, click on *Phone Support*
Internet	⇒	Go to http://www.ab.com/support/abdrives/
E-mail	⇒	support@drives.ra.rockwell.com

Be prepared to provide the following information when you contact Allen-Bradley Drives Technical Support:

- Product Catalog Number
- Product Serial Number
- Firmware Revision Level

Before Applying Power to the AFE

1. Open the power structure enclosure door.
2. If present, remove the protective barriers.

   See Removing AFE Protective Barriers on page 4-10.
3. Check for zero volts between DC+ and DC-.
4. Perform forward and reverse biased diode tests, using a digital multimeter.

   See Performing Forward and Reverse Biased Diode Tests for Power Structure on page 3-3.
5. Confirm that all wiring to the AFE (AC input, ground, DC bus, and I/O) is connected to the correct AFE terminals, and is secure.
6. Verify that AC line power at the disconnect device is within the rated value of the AFE.
7. Verify that the control power voltage is correct.
8. Whenever possible, isolate the AFE from the rest of the DC bus system to enable the AFE to be powered separately.

Service Tools and Equipment

Software Tools

Connected Components Workbench software, DriveExecutive software, or DriveExplorer software are tools that can be used for uploading, downloading, and monitoring system parameters.

Service Tools

The following list contains the basic service tools needed for repair and maintenance measurements.

Item	Description	Details
1	Oscilloscope	Portable, digitizing, dual-channel scope with isolation
2	Current clamp	1000A (ac, rms), signal output
3	High voltage differential probe	P5210 or equivalent
4	Soldering station	Soldering / de-soldering
5	Flash light	—
6	Multi meter	Digital multimeter, capable of AC and DC voltage, continuity, resistance, capacitance measurements, and forward diode bias tests. Fluke Model 87 III or equivalent.
7	Insulation tester	1000V DC
8	Torque wrench	1…12 N•m
9	Torque wrench	6…50 N•m
10	box wrench	7 mm, 8 mm, 10 mm, 13 mm, 17 mm, 19 mm, 22 mm
11	socket extension	230 mm
12	Wrench	7 mm, 8 mm, 10 mm, 13 mm, 17 mm, 19 mm, 22 mm
13	Allen wrench	—
14	Wire cutter	—
15	Nose pliers	—
16	Crimping tools	For cable terminals 1, 5…240
17	Angle wrench	—
18	Flat nose screw driver	7 x 2 mm
19	POZIDRIV screw driver	#1, #2, #3
20	Phillips screw driver	#1, #2, #3
21	Torx screw driver	#25
22	Hexagonal wrench	#4, #5, #6
23	ESD-protected place of work	Working surface, floor covering, seat, and ground connections
24	ESD-protective clothing	Wrist wrap, shoes, overall clothing (coat)
25	Power supply (service)	Capacity of three phase service 400/500/690V AC, 30A
26	20-MAINSTND maintenance stand	Maintenance stand for removing power structure from AFE enclosure
27	Fiber-optic repair kit	Agilent HFBR-4593 Polishing Kit, consisting of a Polishing Fixture, 600 grit abrasive paper, and 3 mm pink lapping film (3M Company, OC3-14). For Agilent HFBR-4532 latching connectors and HFBR-RL cable. See Agilent publications 5988-9777EN and 5988-3625EN.

Notes:

Schematic Diagrams

Frame 13 Circuit Board Connections

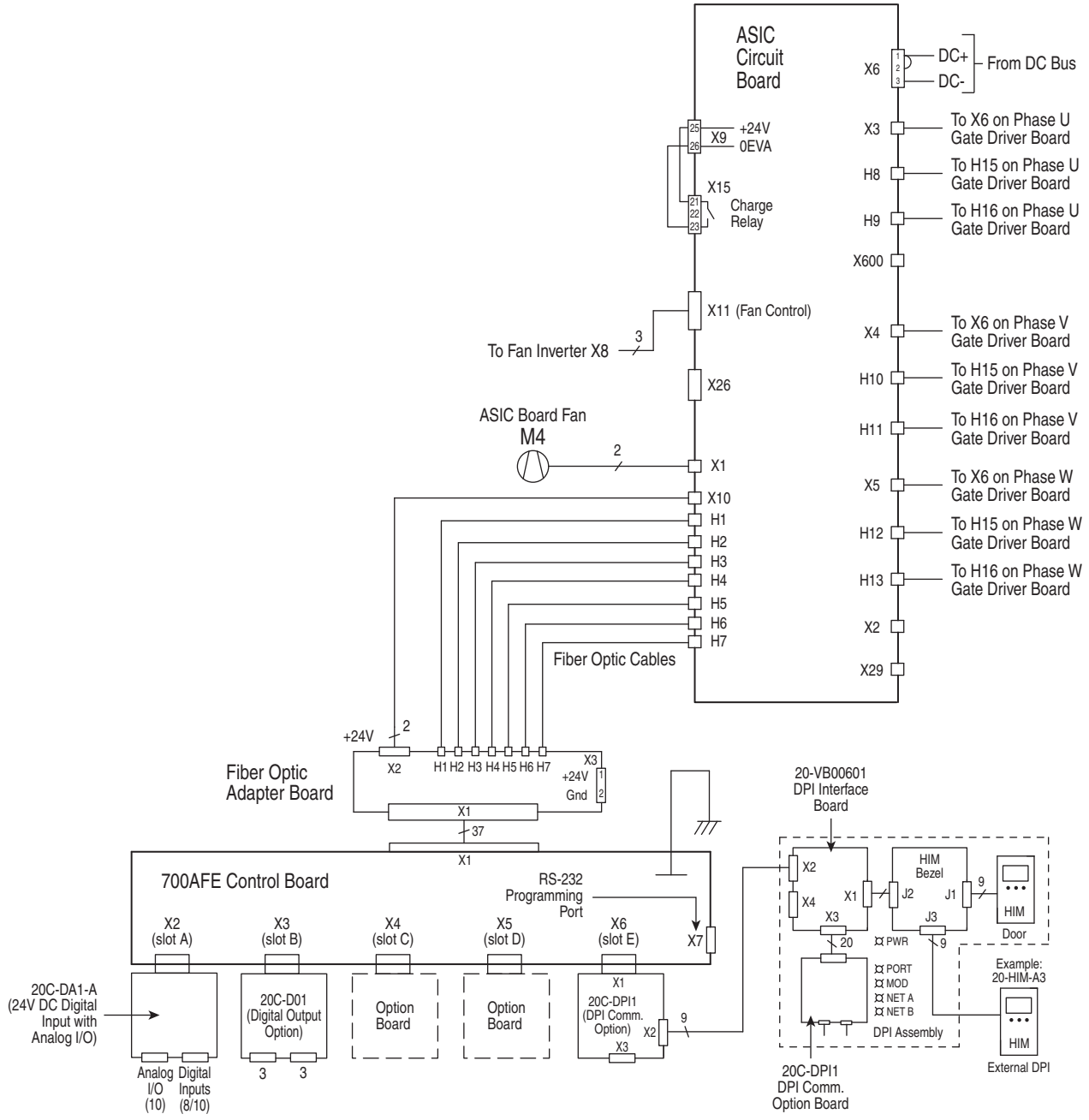


Figure B.1 Frame 13 Circuit Board Connections

Frame 13 Power Structure Power Circuitry Block Diagram

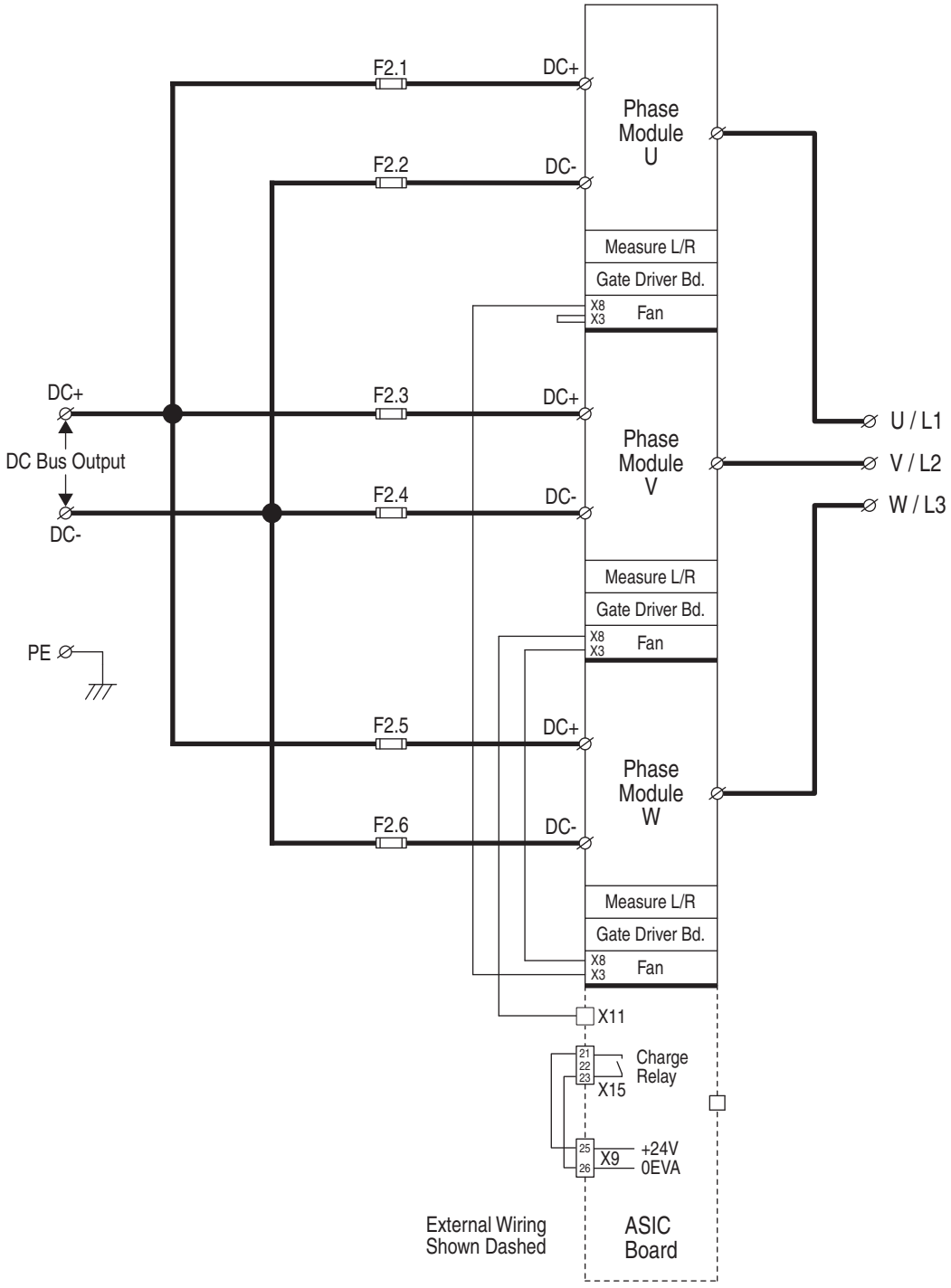


Figure B.2 Frame 13 Power Structure Power Circuitry Block Diagram

Frame 13 Power Module Circuitry

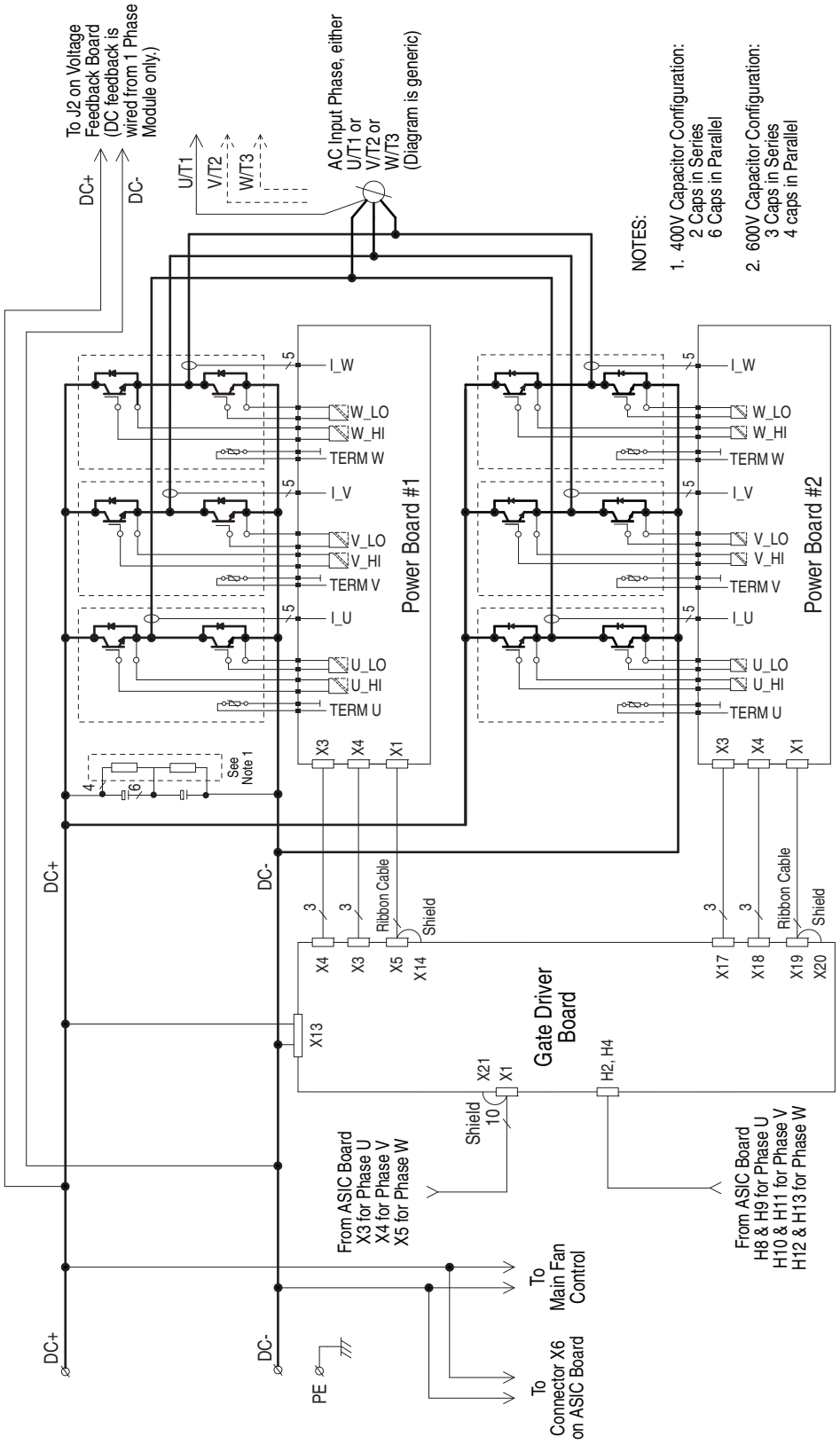


Figure B.3 Frame 13 Power Module Circuitry

Frame 13 Power Structure Main Fan Connections

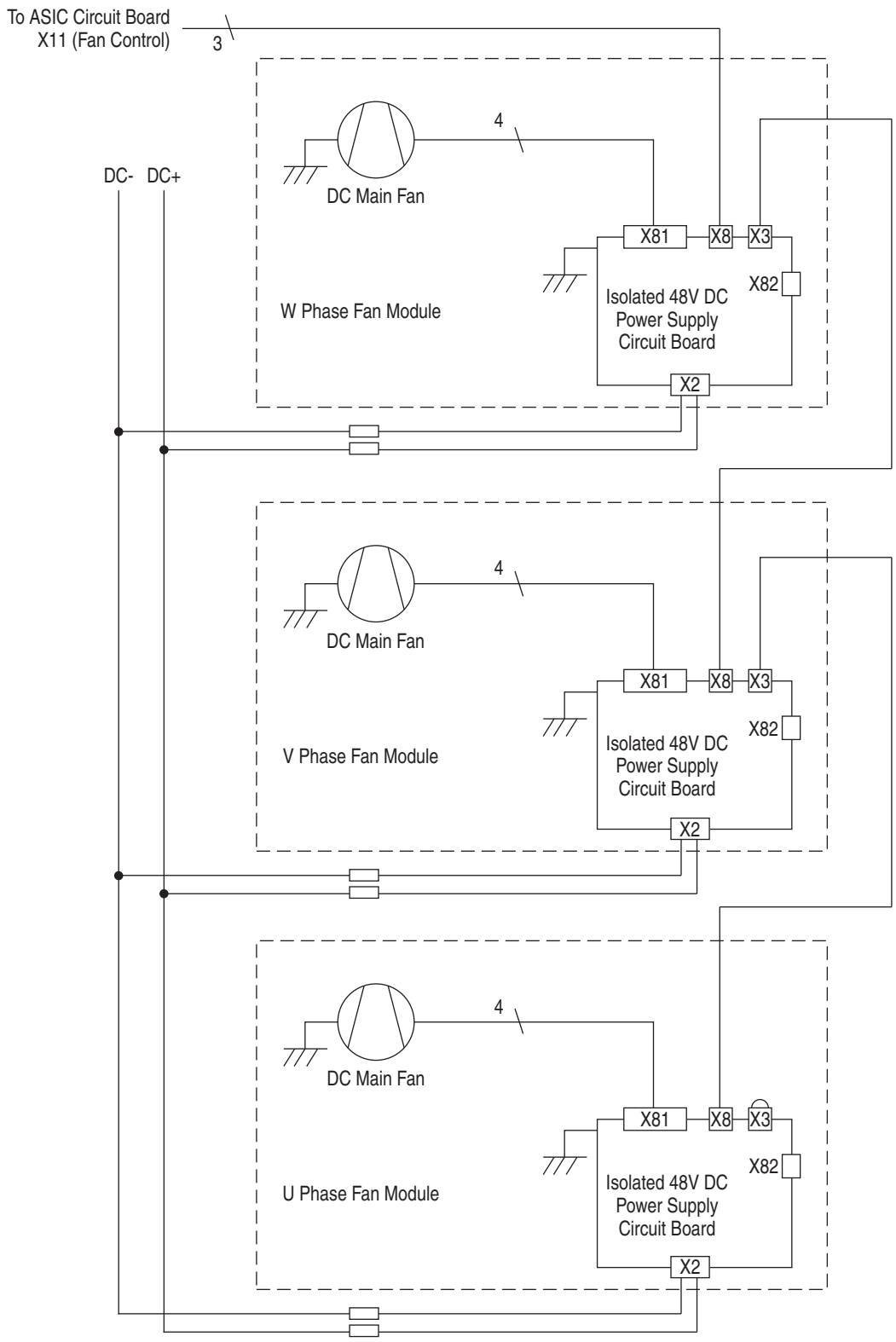


Figure B.4 Frame 13 Power Structure Main DC Fan Connections – newer version

Frame 13 Power Structure Main Fan Connections

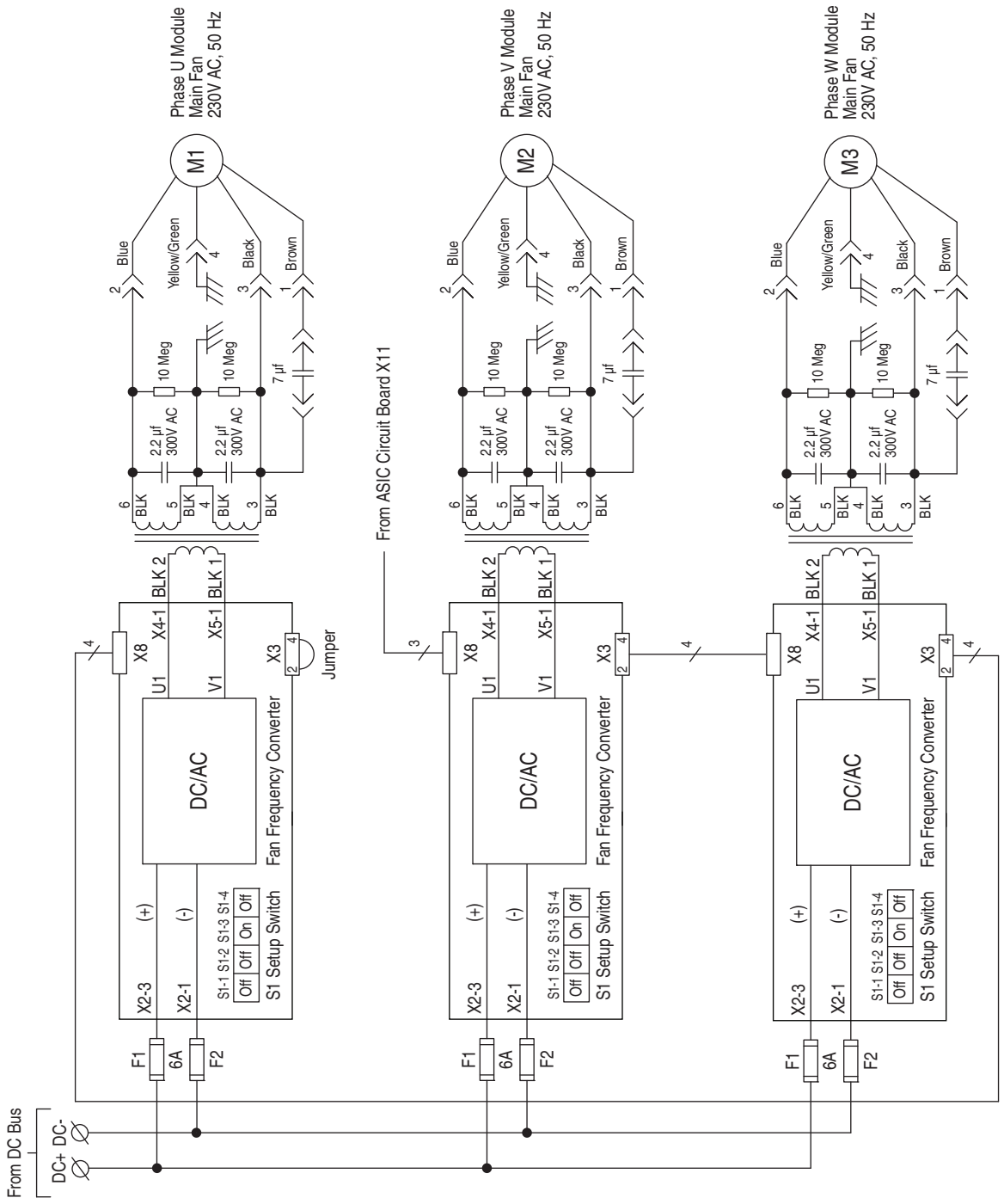


Figure B.5 Frame 13 Power Structure Main AC Fan Connections – older version

Control Wiring Diagram for Frame 13 in IP20 2500 MCC Style Enclosure

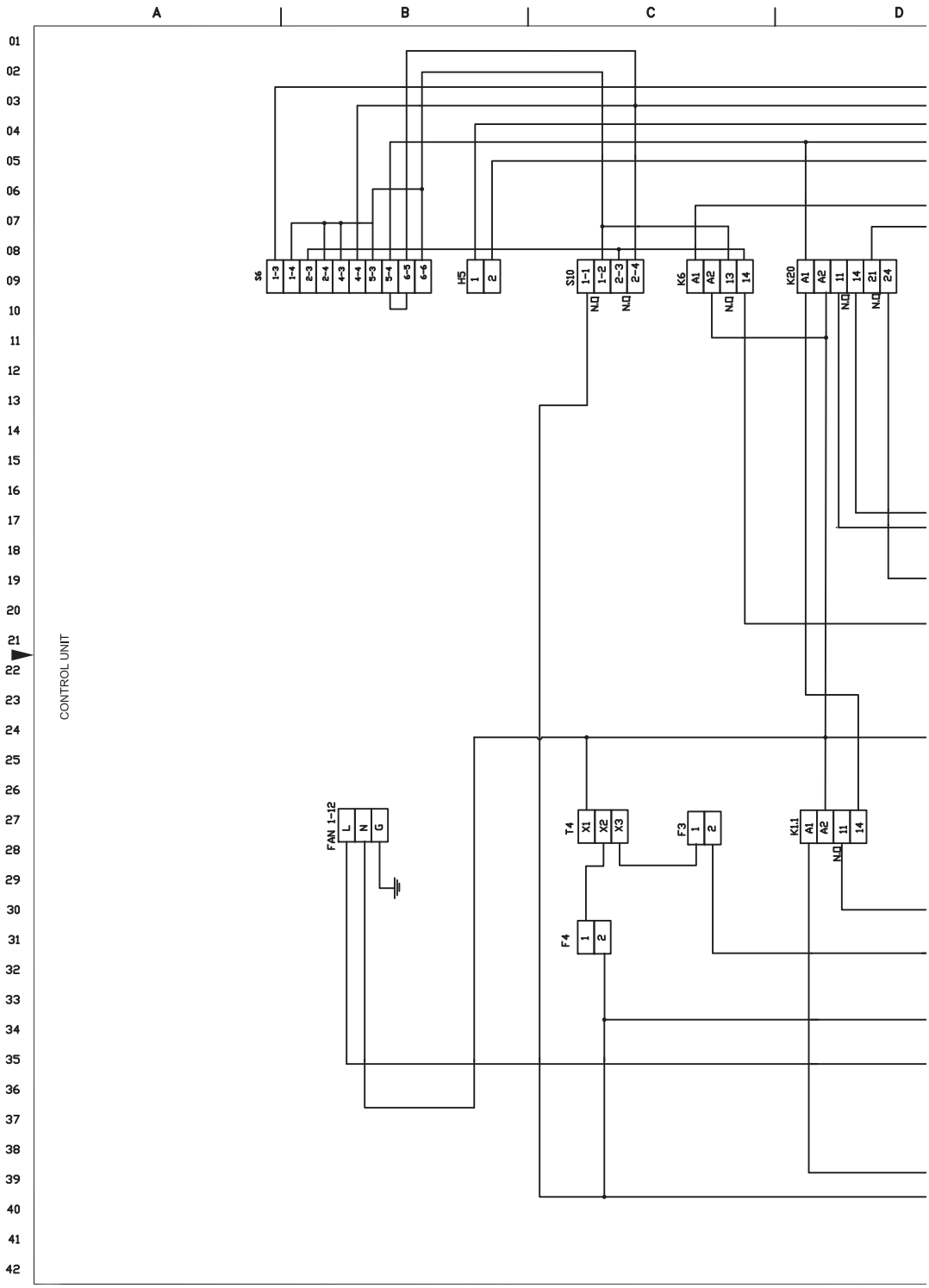
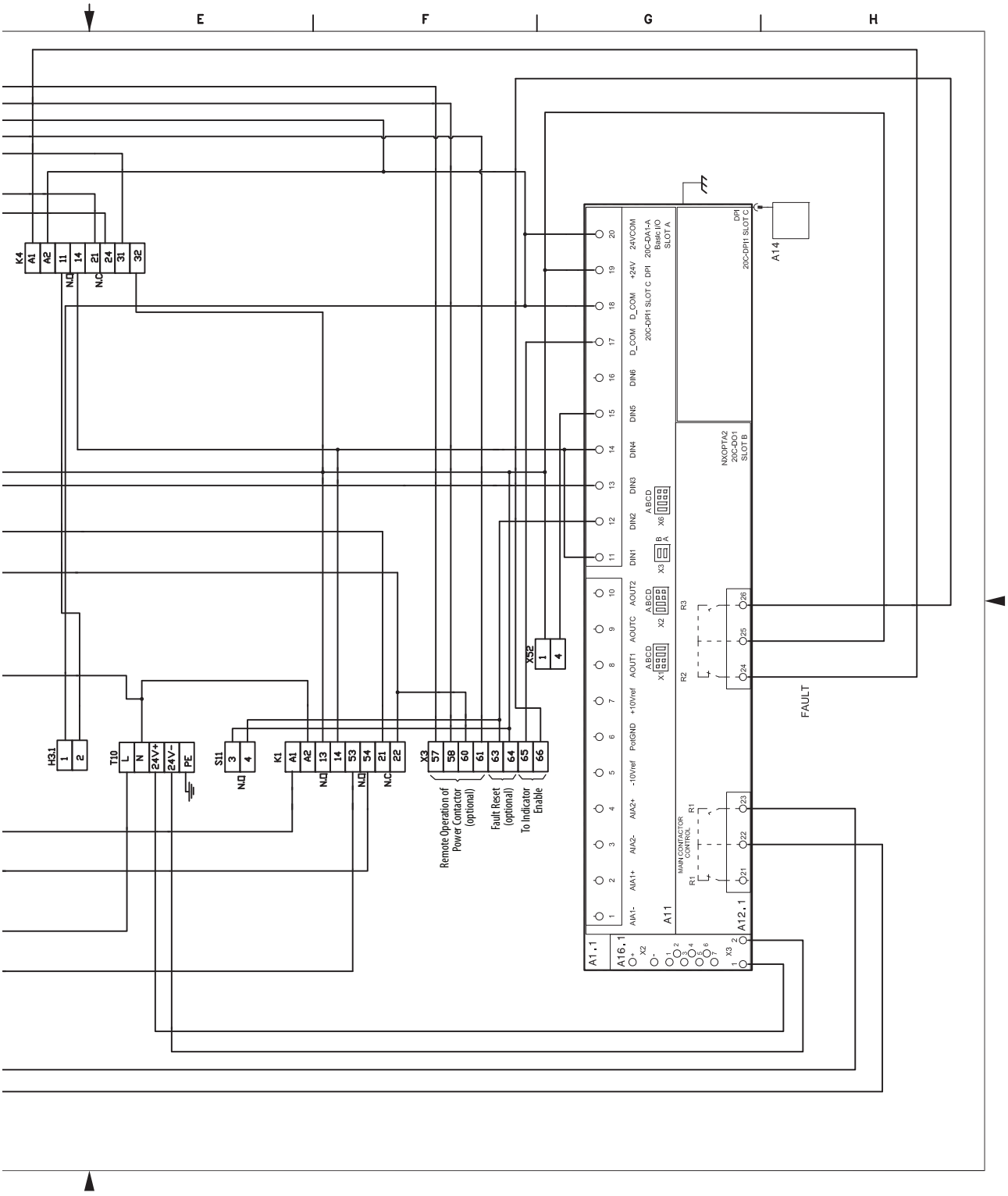


Figure B.6 Control Wiring Diagram for Frame 13 in IP20 2500 MCC Style Enclosure


E
F
G
H
K4
A1
A2
11
14
21
24
31
32
N.O.
N.C.
H3.1
1
2
T10
L
N
24V+
24V-
PE
S11
3
4
K1
13
53
54
22
X3
57
58
60
61
63
64
65
66
Remote Operation of Power Contactor (optional)
Fault Reset (optional)
To Indicator Enable
X52
A11
A12.1
A16.1
A1.1
A14
R1
R2
R3
FAULT
MAIN CONTACTOR CONTROL
NXOPTA2
20C-DO1
SLOT B
20C-DA1-A
Basic I/O
SLOT A
20C-DPI1 SLOT C
DPI
+24V
24VCOM
D_COM
DIN6
DIN5
DIN4
DIN3
DIN2
DIN1
AOUT2
AOUTC
AOUT1
+10Vref
PotGND
-10Vref
AIA2+
AIA2-
AIA1+
AIA1-

System Schematics for Frame 13 in IP20 2500 MCC Style Enclosure

The following system schematics are for the AFE Frame 13 in a IP20 2500 MCC Style enclosure. The PowerFlex AFE catalog number has an enclosure code of P for standard color (or W for optional gray color) as shown in the example catalog string below. For other enclosure designs, contact the supplier of the system for the system schematics.

Position

1-3	*4*	*5-7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*
20Y	**D**	**1K3**	**P**	**0**	**A**	**N**	**N**	**A**	**N**	**A**	**0**
a	*b*	*c*	*d*	*e*	*f*	*g*	*h*	*i*	*j*	*k*	*l*

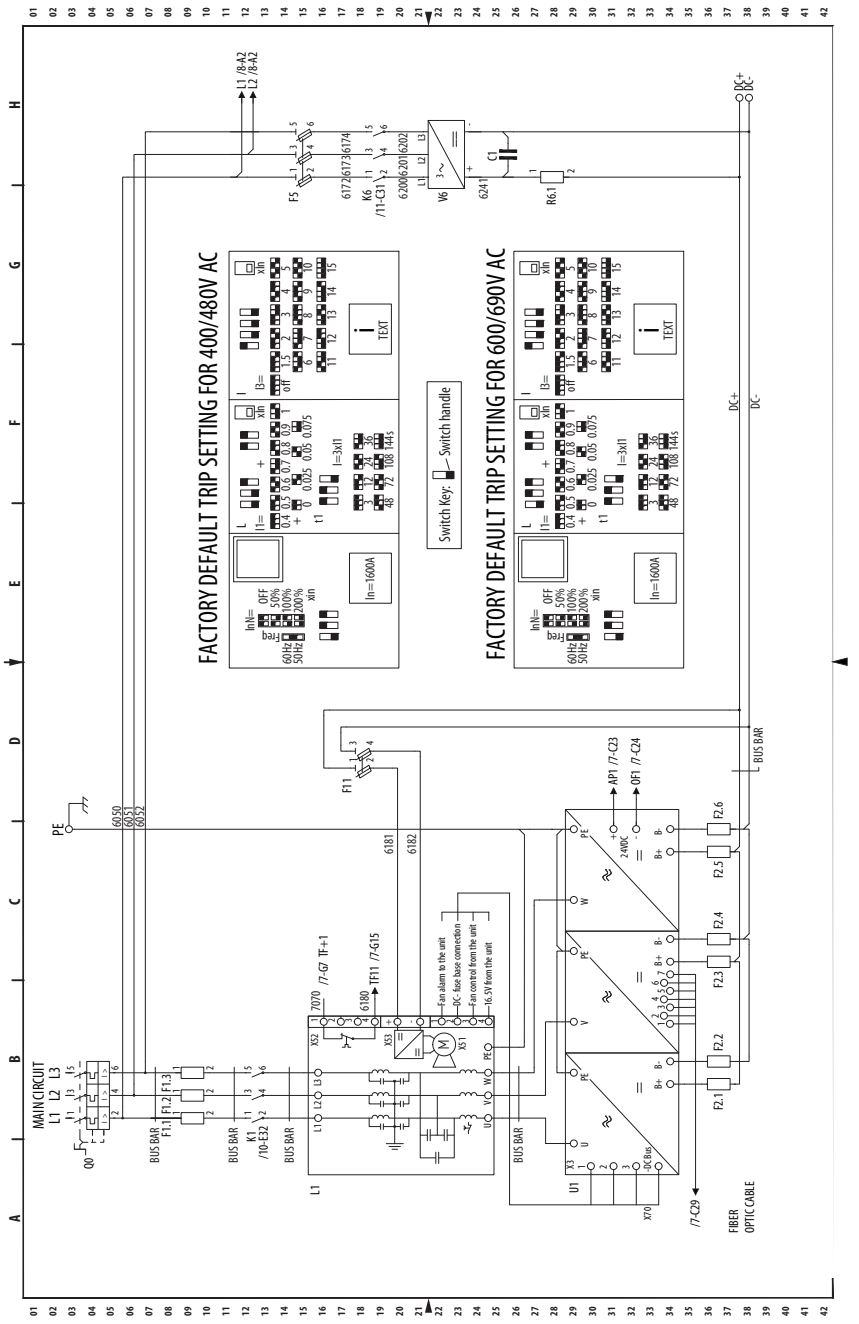


Figure B.7 Frame 13 in IP20 2500 MCC Style Enclosure – Sheet 6 (400/480V and 600/690V)

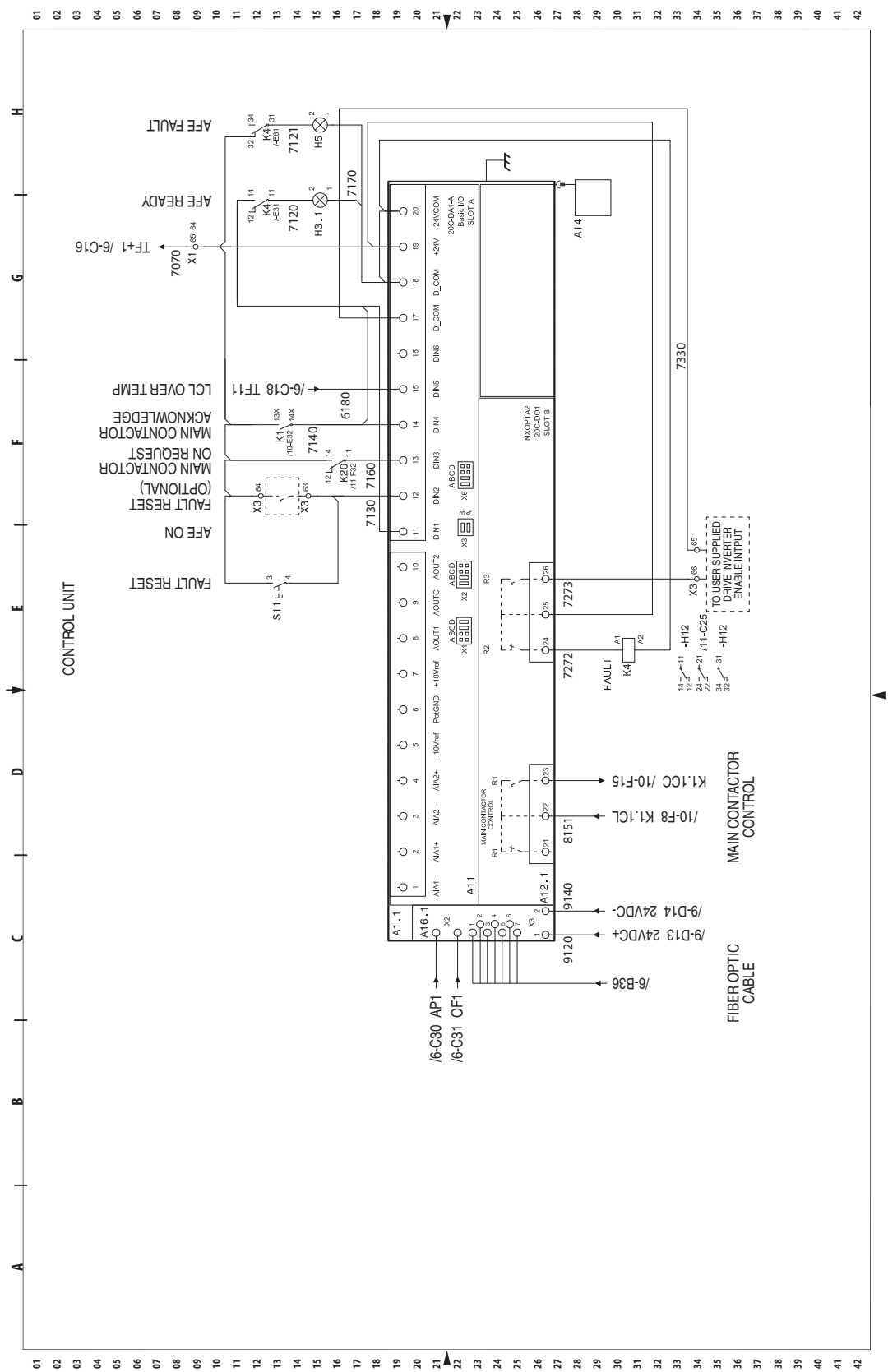


Figure B.8 Frame 13 in IP20 2500 MCC Style Enclosure – Sheet 7 (400/480V and 600/690V)

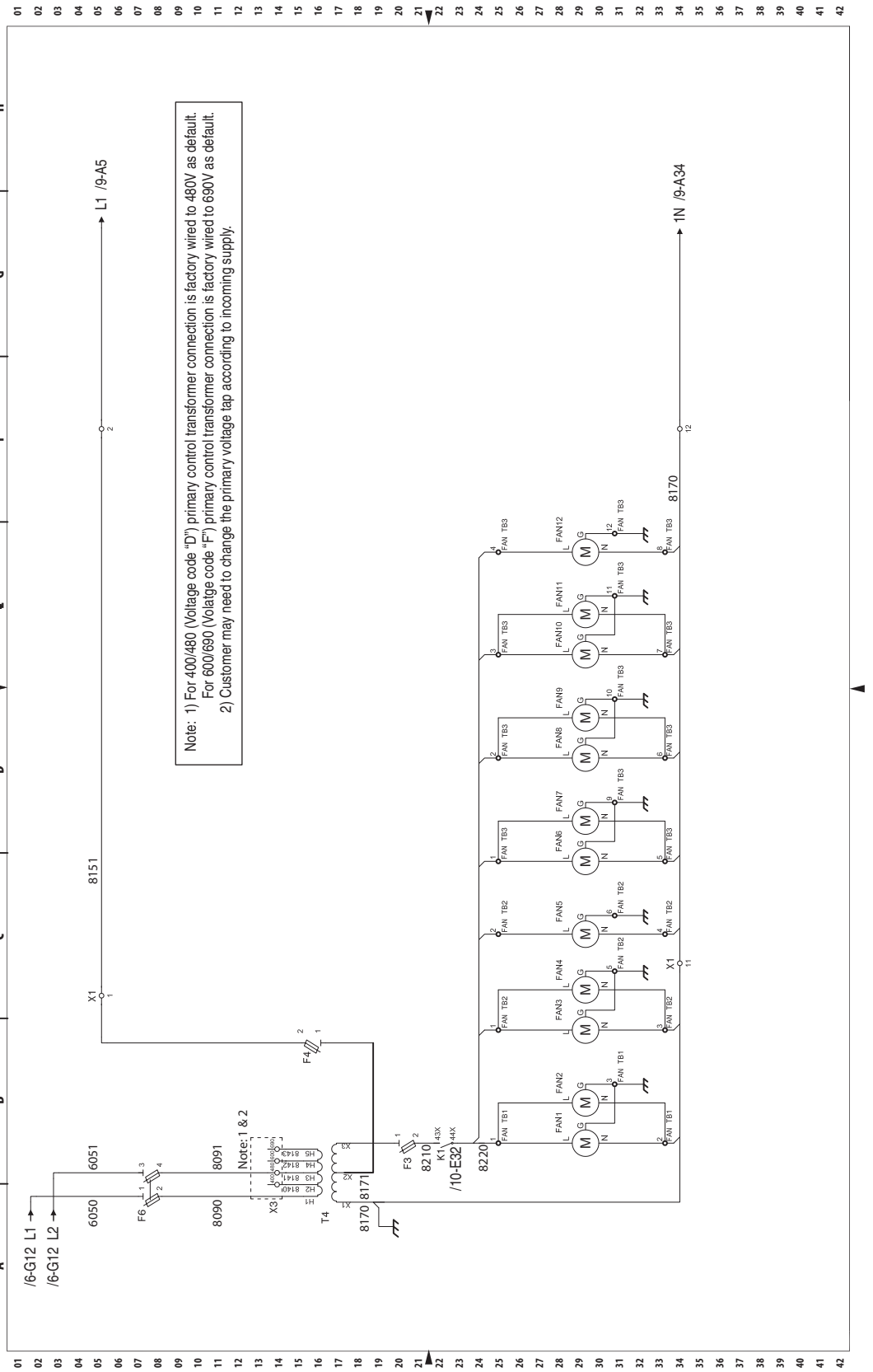


Figure B.9 Frame 13 in IP20 2500 MCC Style Enclosure – Sheet 8 (400/480V and 600/690V)

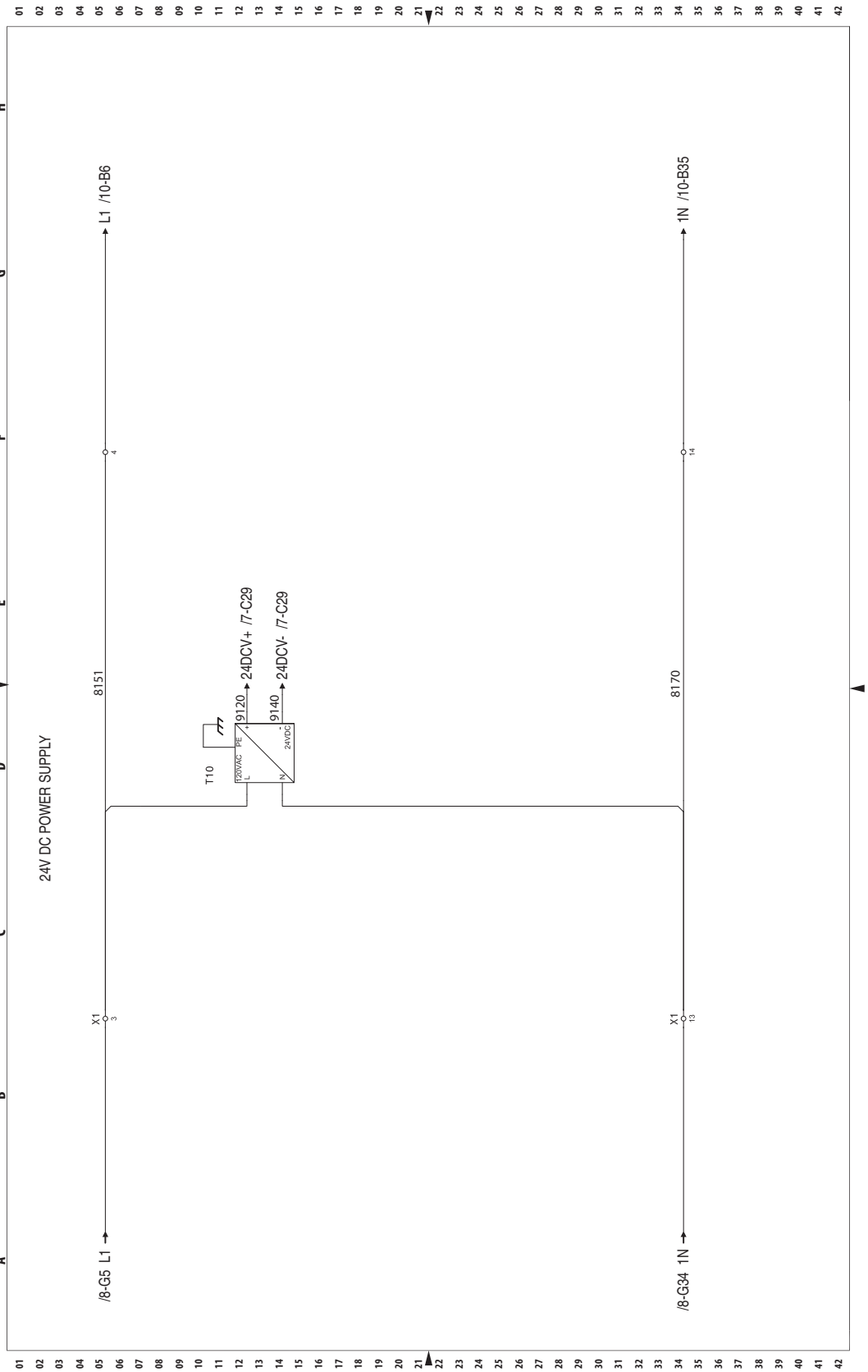


Figure B.10 Frame 13 in IP20 2500 MCC Style Enclosure – Sheet 9 (400/480V and 600/690V)

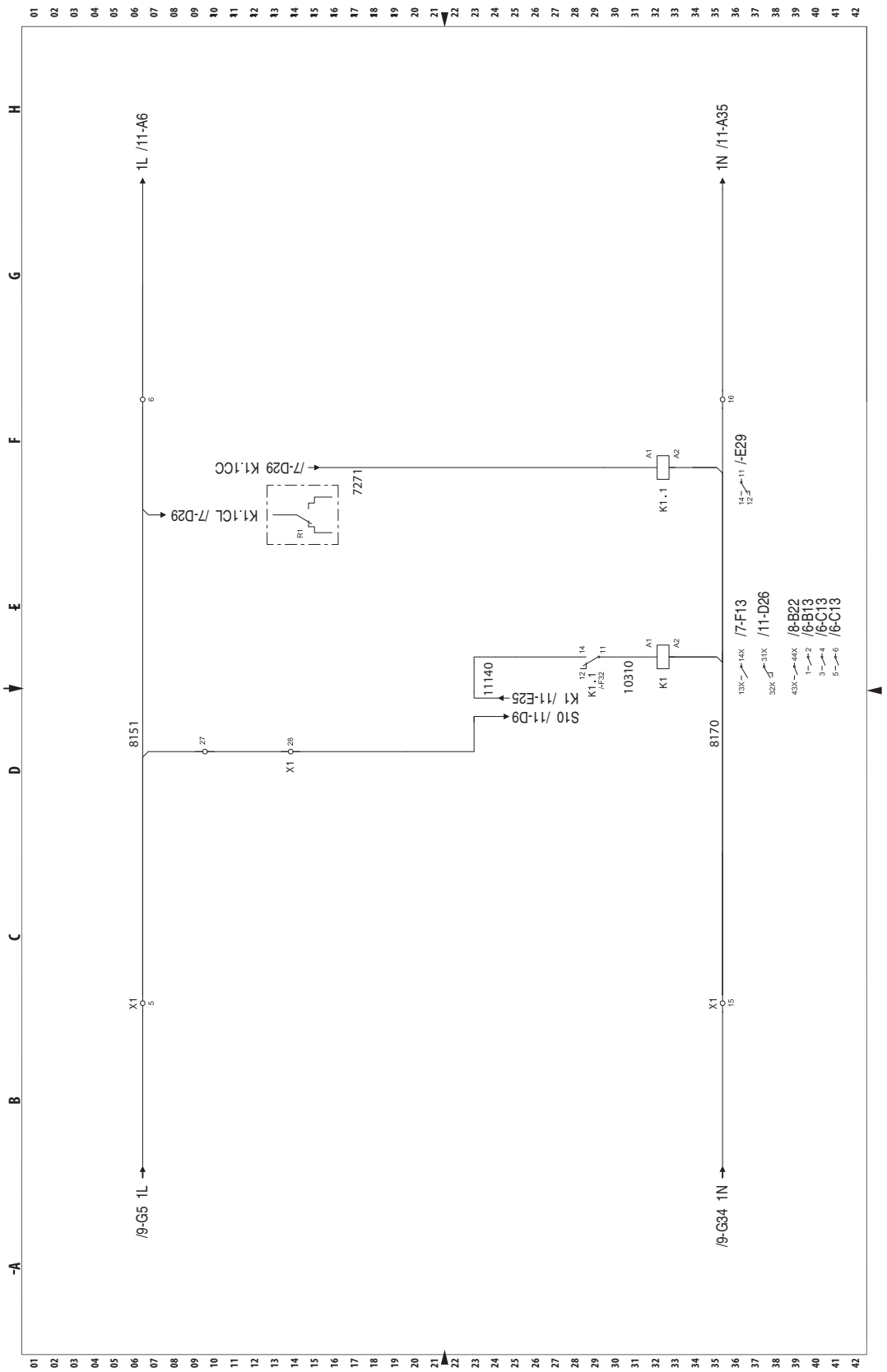


Figure B.11 Frame 13 in IP20 2500 MCC Style Enclosure – Sheet 10 (400/480V and 600/690V)

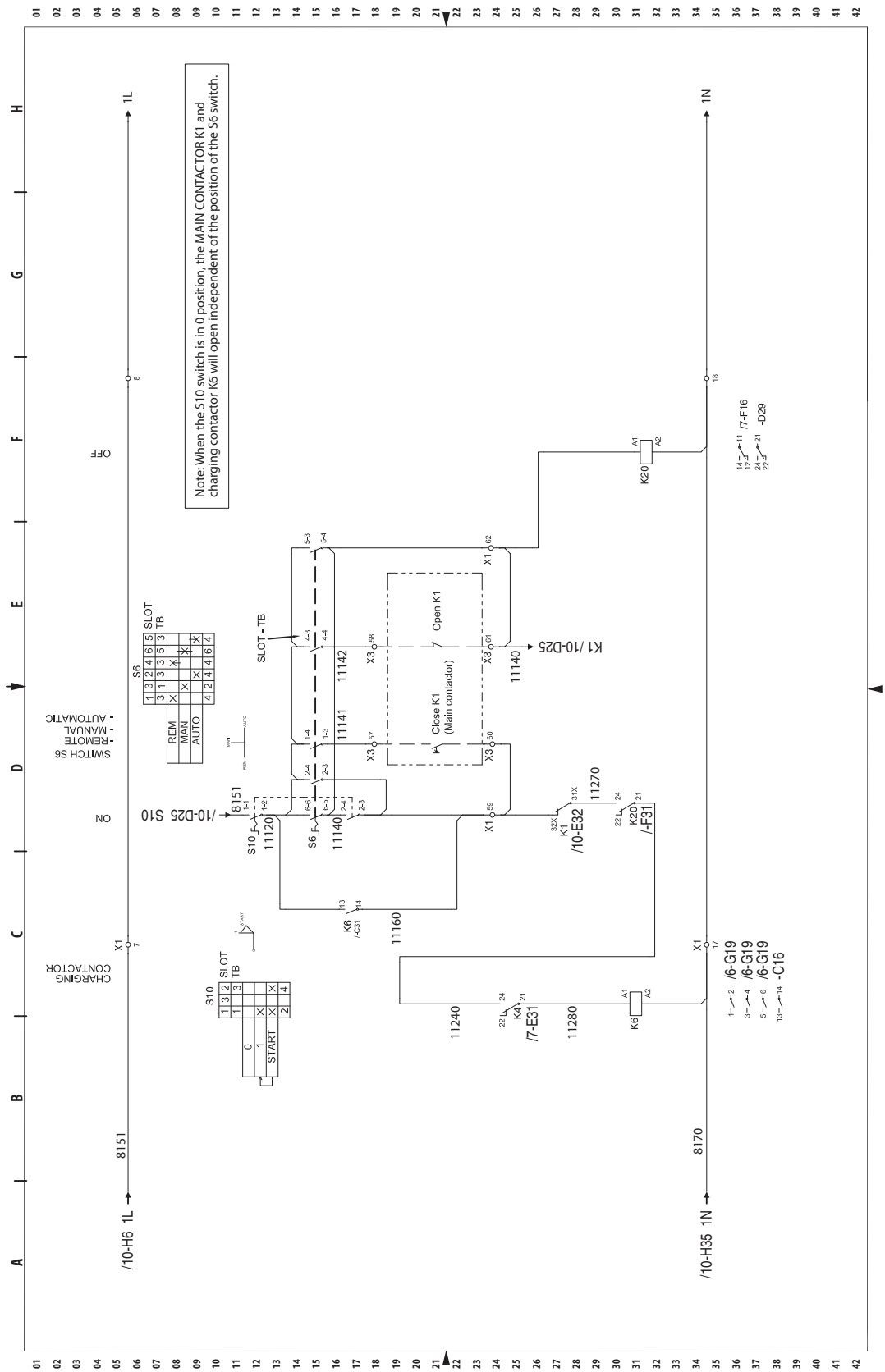


Figure B.12 Frame 13 in IP20 2500 MCC Style Enclosure – Sheet 11 (400/480V and 600/690V)

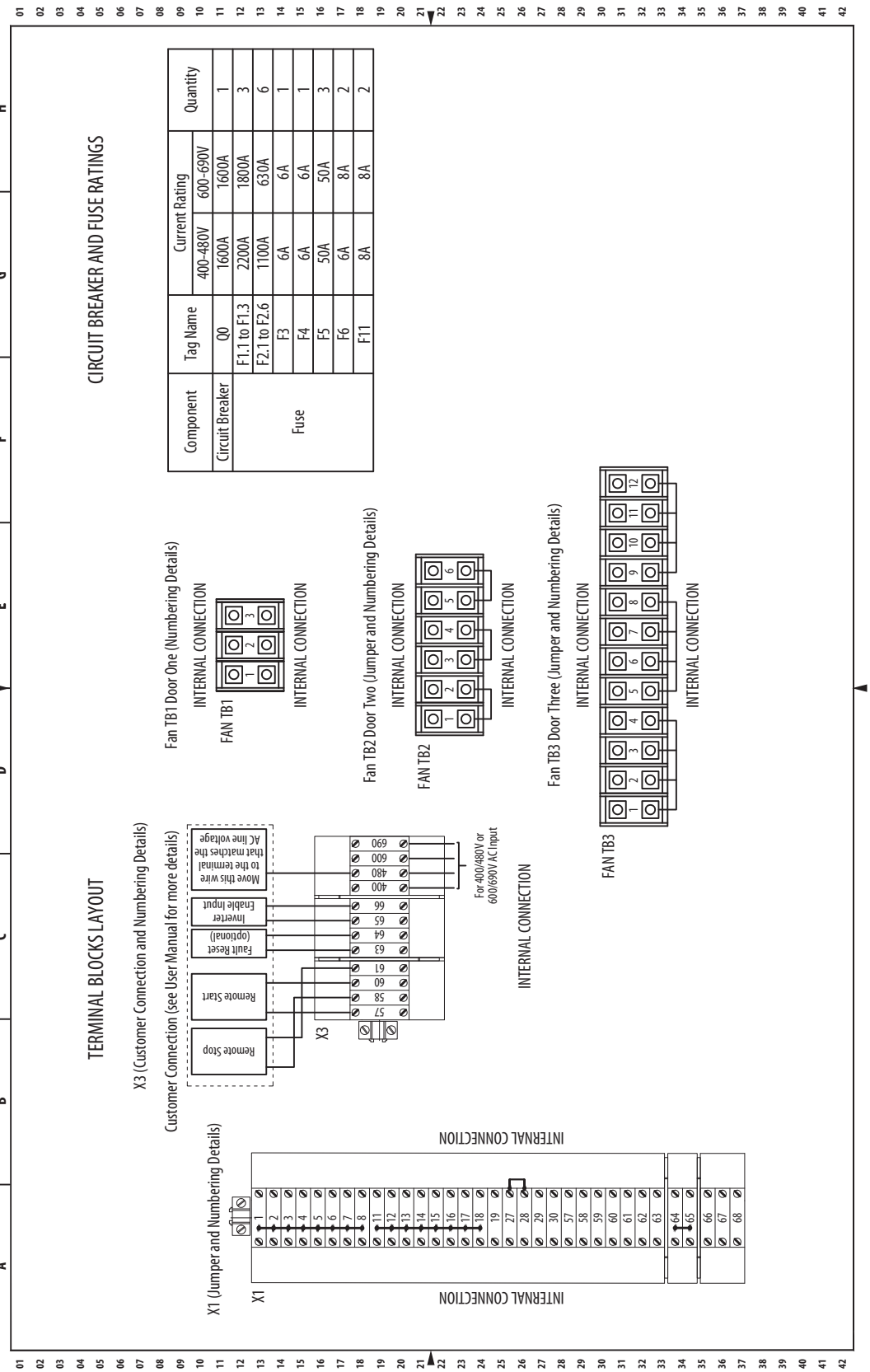


Figure B.13 Frame 13 in IP20 2500 MCC Style Enclosure – Sheet 12 (Terminal Block Layout, and Circuit Breaker and Fuse Ratings

Control Wiring Diagram for Frame 13 in IP21 Rittal Enclosure

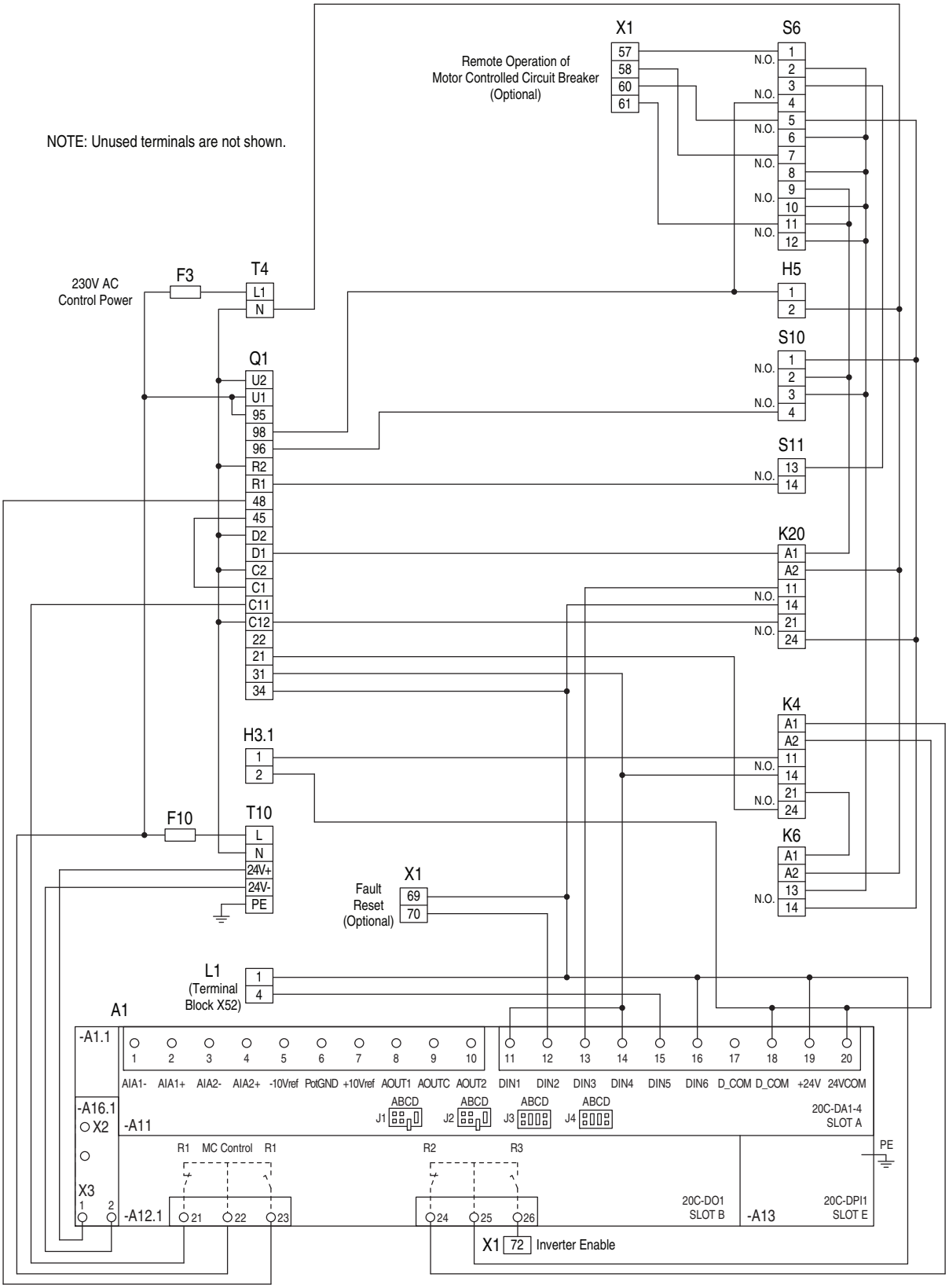


Figure B.14 Control Wiring Diagram for Frame 13 in IP21 Rittal Enclosure

System Schematics for Frame 13 in IP21 Rittal Enclosure

The following system schematics are for the Frame 13 AFE in a IP21 Rittal enclosure. The PowerFlex AFE catalog number has an enclosure code of A as shown in the example catalog string below. For other enclosure designs, contact the supplier of the system for the system schematics.

Position

1-3	*4*	*5-7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*
20Y	**D**	**1K3**	**A**	**0**	**A**	**N**	**N**	**A**	**N**	**A**	**0**
a	*b*	*c*	*d*	*e*	*f*	*g*	*h*	*i*	*j*	*k*	*l*

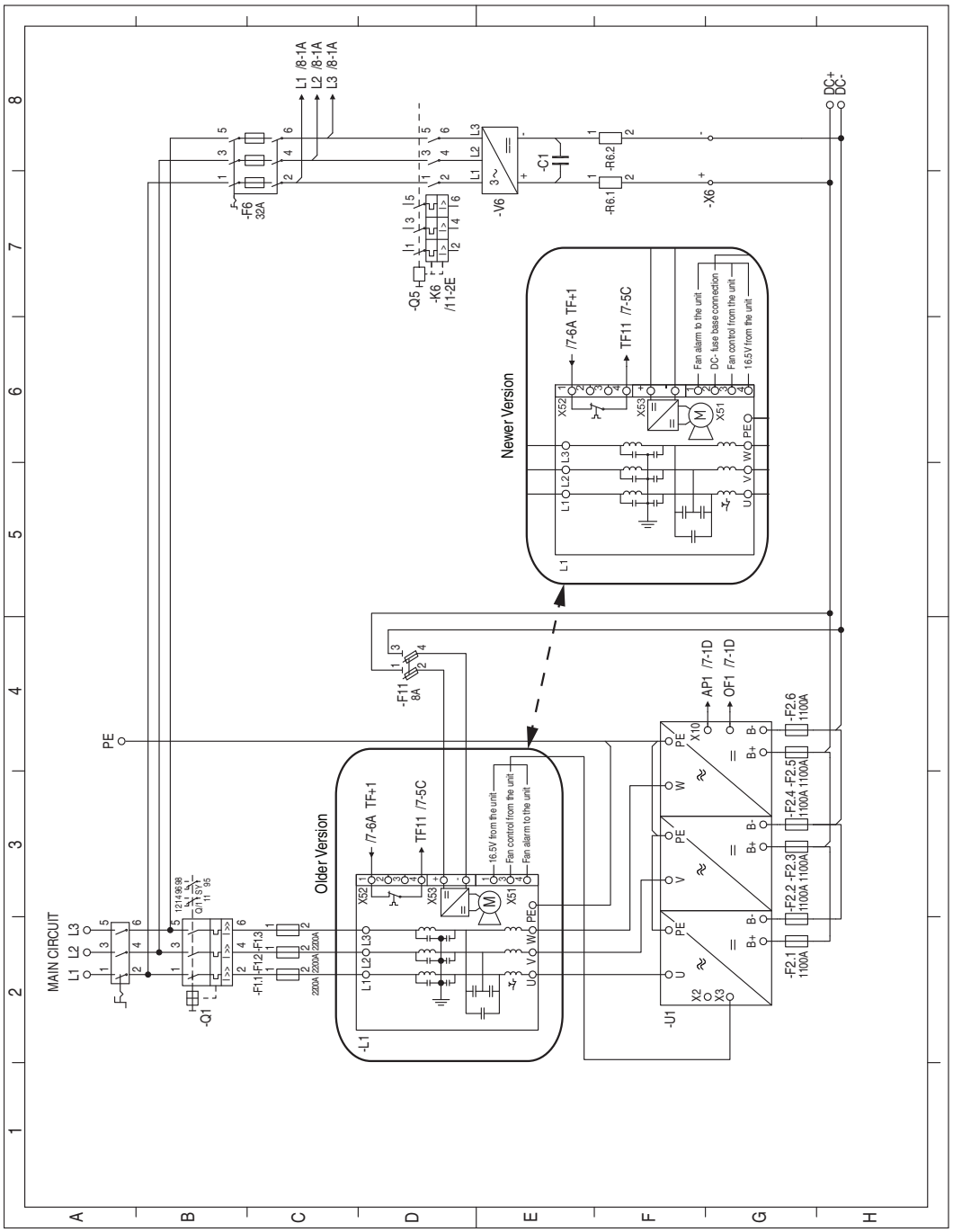


Figure B.15 Frame 13 in IP21 Rittal Enclosure – Sheet 6 (400/480V and 600/690V)

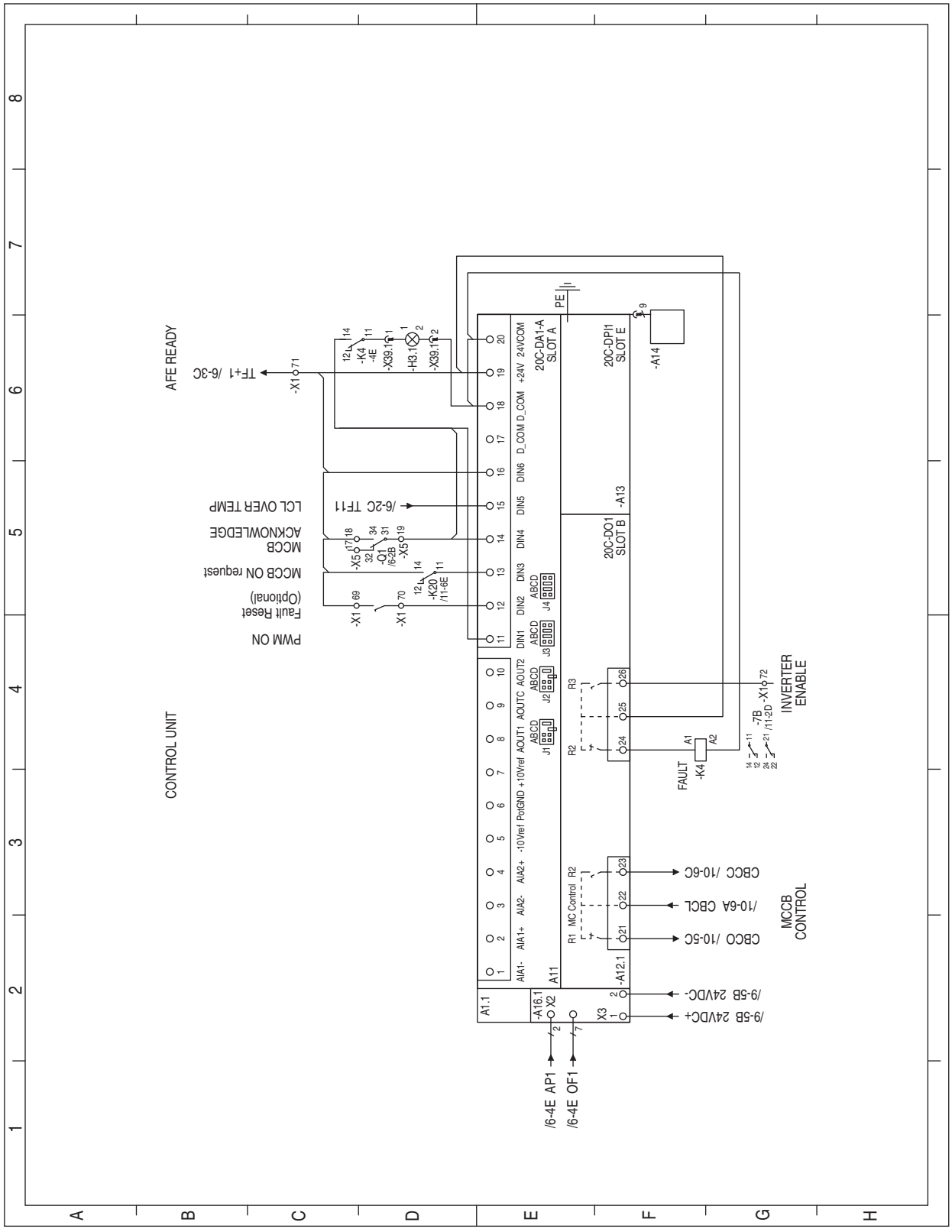


Figure B.16 Frame 13 in IP21 Rittal Enclosure – Sheet 7 (400/480V and 600/690V)

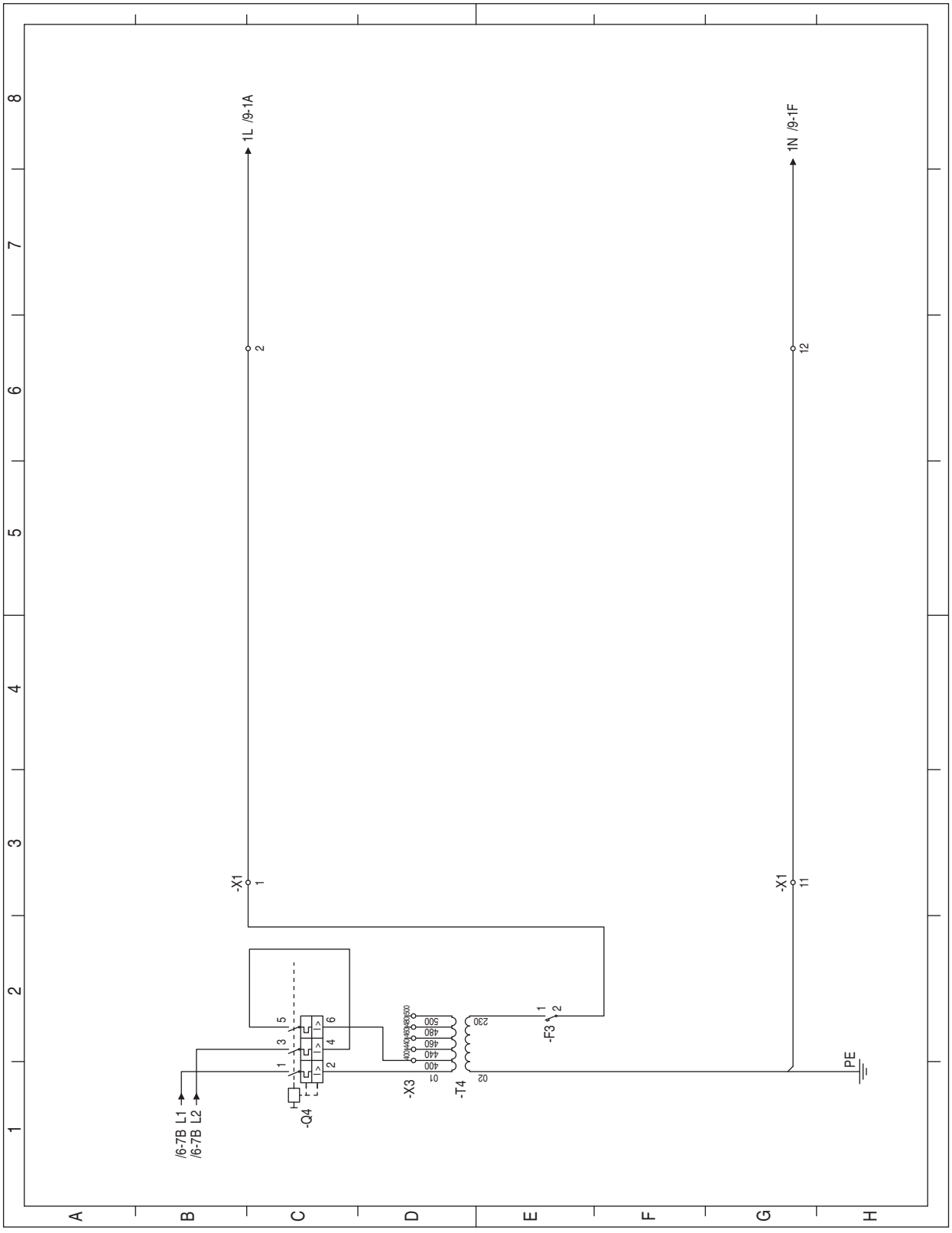


Figure B.17 Frame 13 in IP21 Rittal Enclosure – Sheet 8A (only 400/480V)

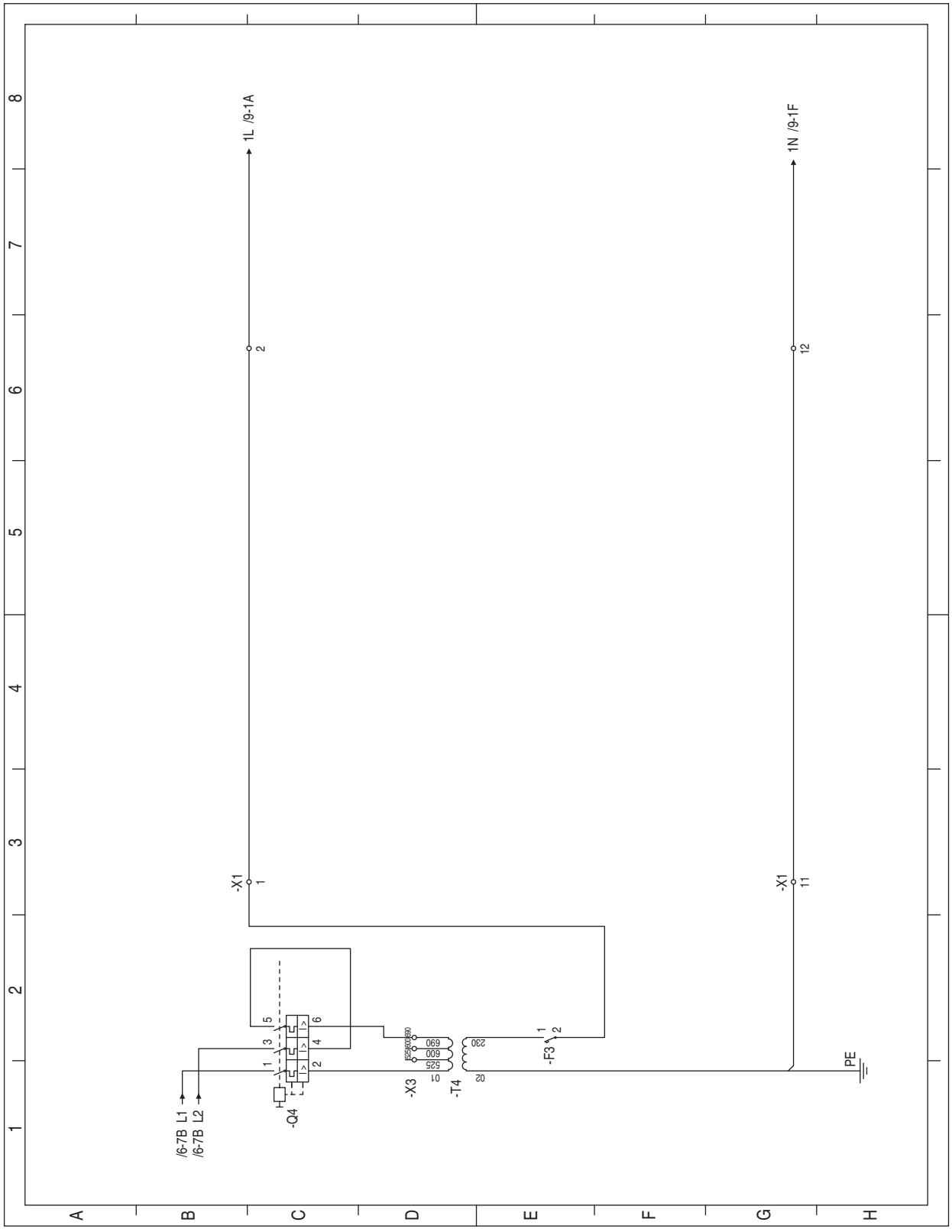


Figure B.18 Frame 13 in IP21 Rittal Enclosure – Sheet 8B (only 600/690V)

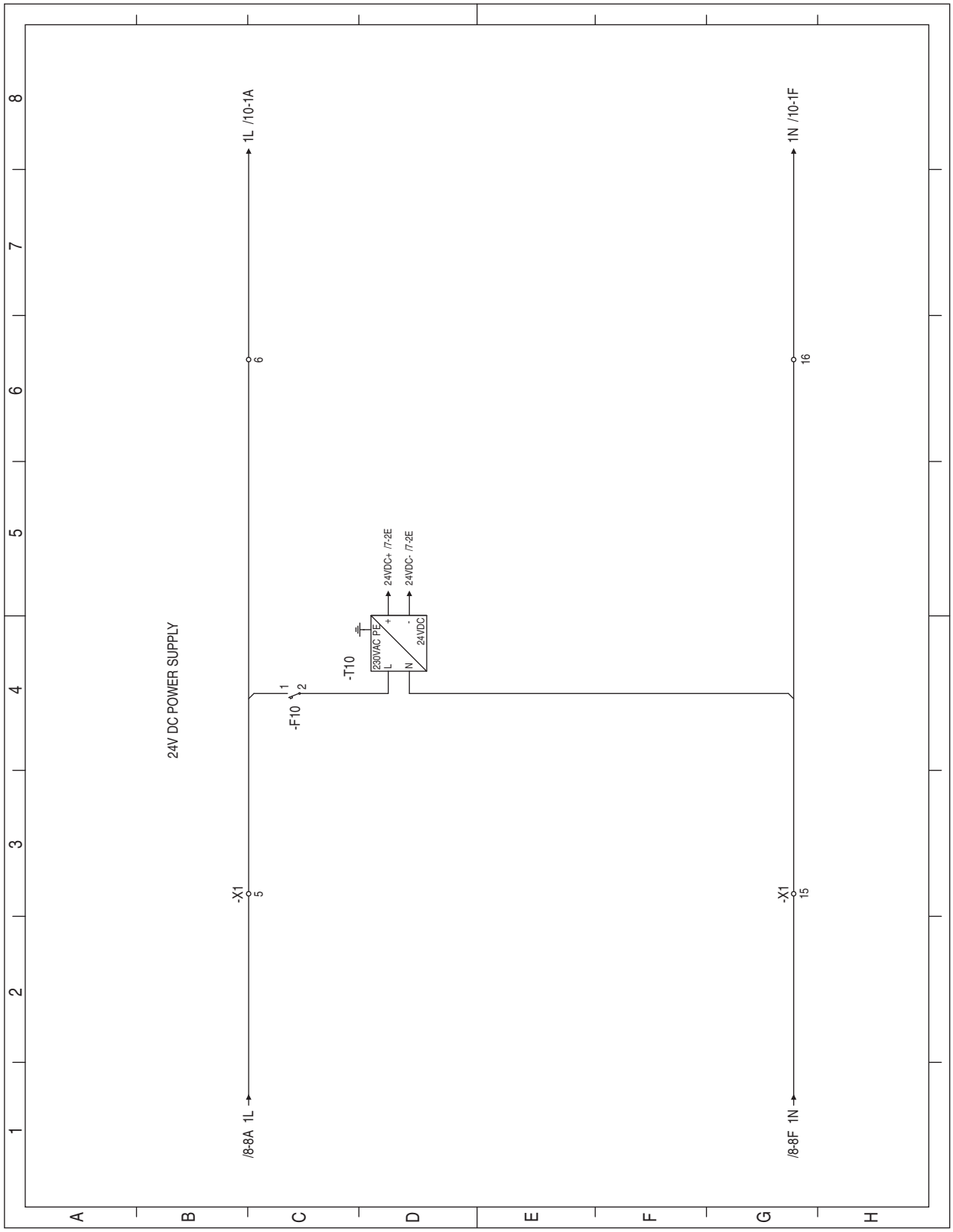


Figure B.19 Frame 13 in IP21 Rittal Enclosure – Sheet 9 (400/480V and 600/690V)

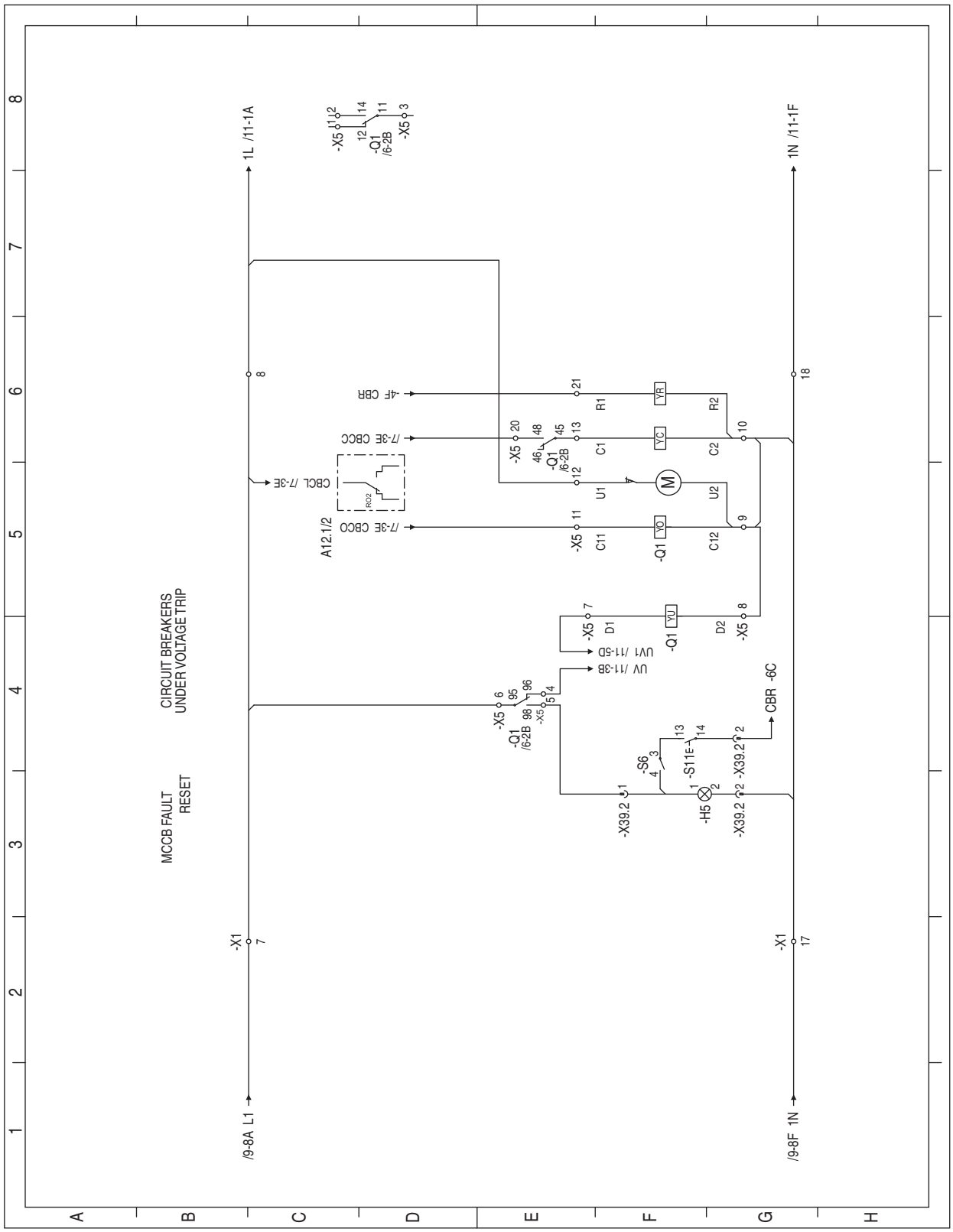


Figure B.20 Frame 13 in IP21 Rittal Enclosure – Sheet 10 (400/480V and 600/690V)

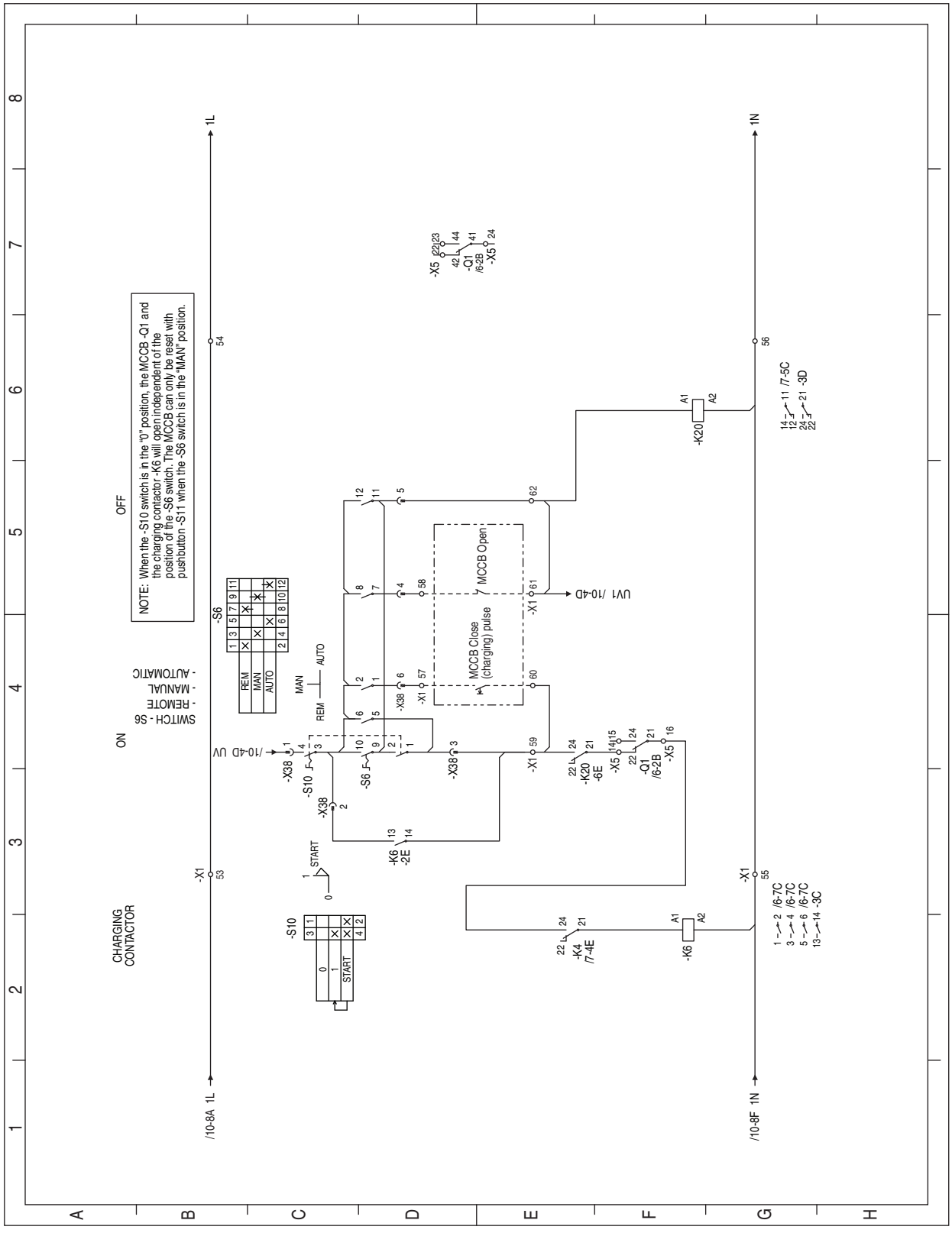


Figure B.21 Frame 13 in IP21 Rittal Enclosure – Sheet 11 (400/480V and 600/690V)

Connector Descriptions

Circuit Board Connections

The following tables detail the connection points for the Frame 13 PowerFlex Active Front End circuit boards and components.

Table C.A Fiber Optic Adapter Board-to-ASIC Circuit Board Connections

Fiber Optic Adapter Connector	Type	Signal Description: Reference to ASIC Board	Type	ASIC Board Fiber Connector (1)
H1	TX	Gate_Enable	RX	H1
H2	TX	U_Gate	RX	H2
H3	TX	V_Gate	RX	H3
H4	TX	W_Gate	RX	H4
H5	TX	A/D Convert	RX	H5
H6	TX	VBUS_RX	RX	H6
H7	RX	VBUS_TX	TX	H7
X2	From	+24V DC Power	To	X10
X3	From	Auxiliary 24V DC Power Supply	To	T10 power supply on control panel

(1) See Figure C.1 on page C-3 for ASIC board fiber-optic connectors.

Important: When mishandled, the ability of fiber optic cables to transmit data is greatly diminished.

ATTENTION: Hazard of permanent eye damage exists when using optical transmission equipment. This product emits intense light and invisible radiation. Do not look into fiber optic ports or fiber optic cable connectors.

Important: The minimum inside bend radius for fiber optic cable is 25.4 mm (1 in.). Any bends with a shorter inside radius can permanently damage the fiber optic cable. Signal attenuation increases with decreased inside bend radii.

Table C.B ASIC Board-to-Gate Driver Board Connections

ASIC Board	Gate Driver Board	Signal Description
X3	X1	'U' phase
X4	X1	'V' phase
X5	X1	'W' phase
H13 (WL) H12 (WH) H11 (VL) H10 (VH) H9 (UL) H8 (UH)	(WL) H4 (WH) H2 (VL) H4 (VH) H2 (UL) H4 (UH) H2	Fiber Optic Gate Signals (connect UH to UH, UL to UL, and so forth)

Ribbon Cable	Signal Description
Pin 1	U_Feedback
Pin 2	U_Power_OK
Pin 3	U_DTR (1)
Pin 4	U_ETR (2)
Pin 5	U_ITR (3)
Pin 6	U_DC-
Pin 7	UI
Pin 8	U_DC-_I
Pin 9	U_TEMP
Pin 10	U_DC-T

Ribbon Cable	Signal Description
Pin 1	V_Feedback
Pin 2	V_Power_OK
Pin 3	V_DTR (1)
Pin 4	V_ETR (2)
Pin 5	V_ITR (3)
Pin 6	V_DC-
Pin 7	VI
Pin 8	V_DC-_I
Pin 9	V_TEMP
Pin 10	V_DC-T

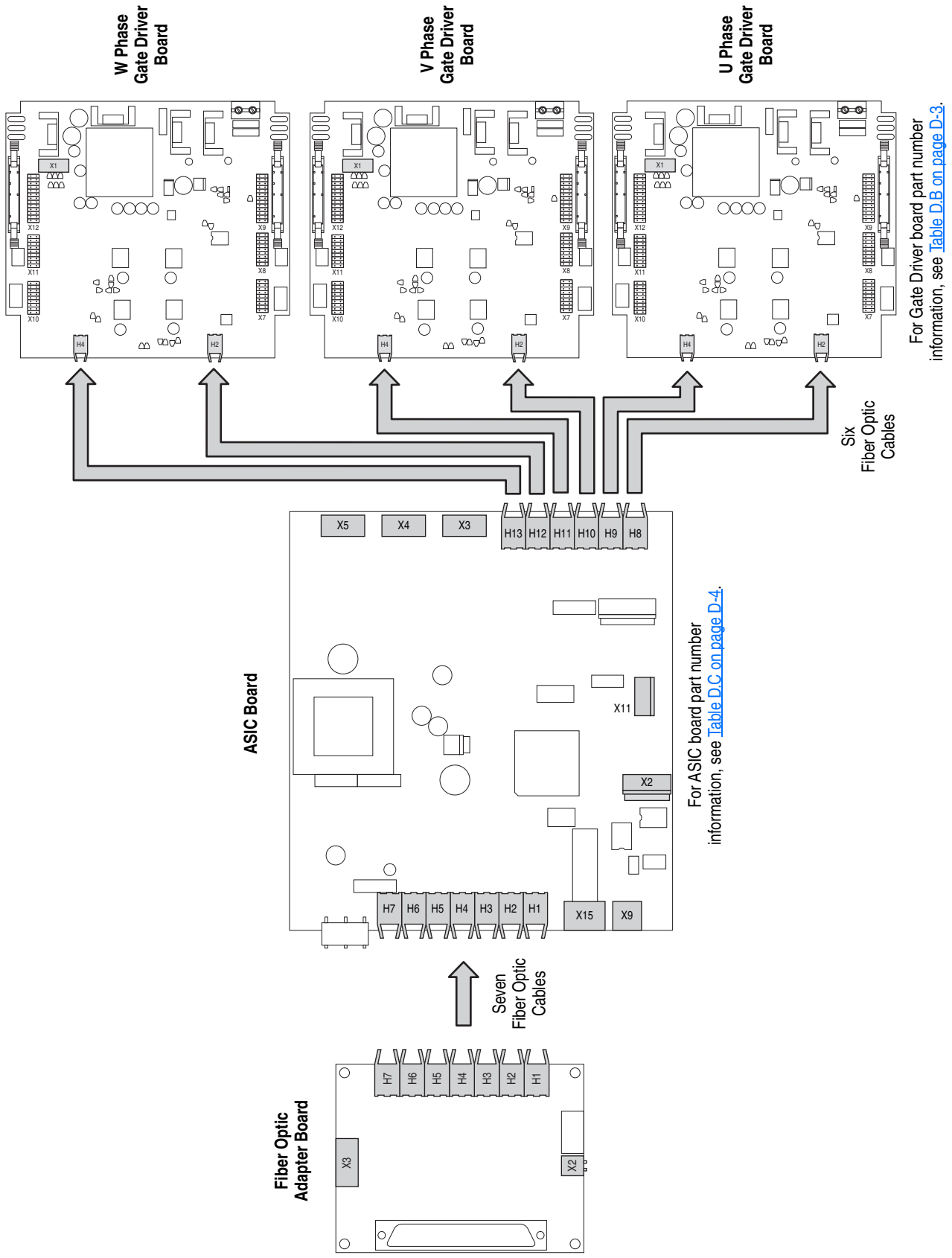
Ribbon Cable	Signal Description
Pin 1	W_Feedback
Pin 2	W_Power_OK
Pin 3	W_DTR (1)
Pin 4	W_ETR (2)
Pin 5	W_ITR (3)
Pin 6	W_DC-
Pin 7	WI
Pin 8	W_DC-_I
Pin 9	W_TEMP
Pin 10	W_DC-T

(1) DTR = N Desat

(2) ETR = Phase I^2T

(3) ITR = Phase Overcurrent

Figure C.1 Fiber Optic Cable Routing



Hardware Connections

Figure C.2 AFE Power Structure Fan Inverter Circuit Board Connectors

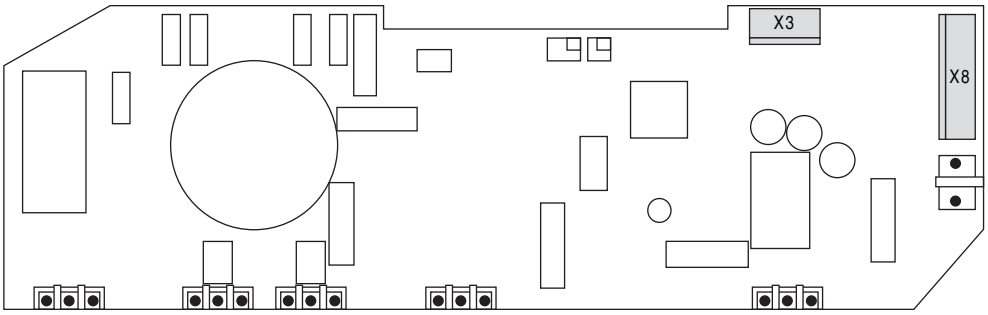


Table C.C ASIC Board - AFE Power Structure V Phase Fan Inverter Board Connections

ASIC Board Connector (1)		Pin	Signal Description		Pin	Phase V Fan Inverter Board Connector
X11	From	2	ASIC_+15V	To	2	X8
	From	3	FAN_CONTROL	To	3	
	To	4	FAN_ALARM	From	7	

(1) See Figure C.1 on page C-3 for ASIC board connectors.

Table C.D Phase V Fan Inverter Board - W Phase Fan Inverter Board Connections

Phase V Fan Inverter Board Connector		Pin	Signal Description		Pin	Phase W Fan Inverter Board Connector
X3	From	2	+15V	To	2	X8
	From	3	FAN_CONTROL NEXT	To	3	
	To	4	FAN_ALARM	From	7	

Table C.E Phase W Fan Inverter Board - U Phase Fan Inverter Board Connections

Phase W Fan Inverter Board Connector		Pin	Signal Description		Pin	Phase U Fan Inverter Board Connector
X3	From	2	+15V	To	2	X8
	From	3	FAN_CONTROL NEXT	To	3	
	To	4	FAN_ALARM	From	7	

For part number information, see the PowerFlex 700H, 700S, and 700AFE Drive Fan Systems Installation Instructions, publication PFLEX-IN029.

Figure C.3 LCL Filter Fan Inverter Circuit Board Connectors

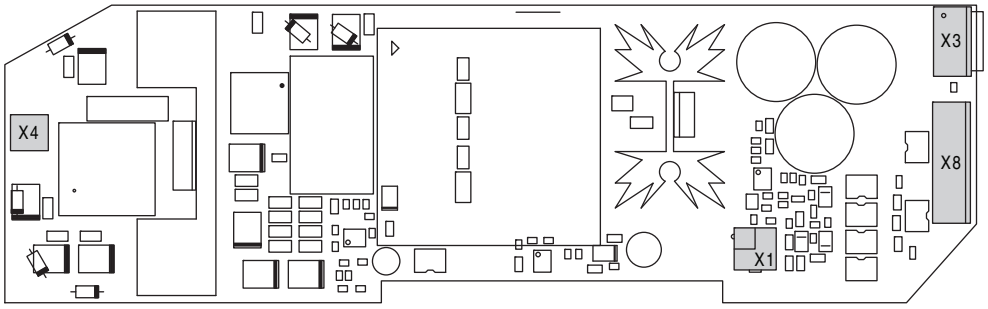


Table C.F LCL Filter Fan Inverter Circuit Board Connections

LCL Filter DC Fan Inverter Board	LCL Filter DC Fan Assembly
X1	X1
X3	X3
X8	X51
X4	X53

Notes:

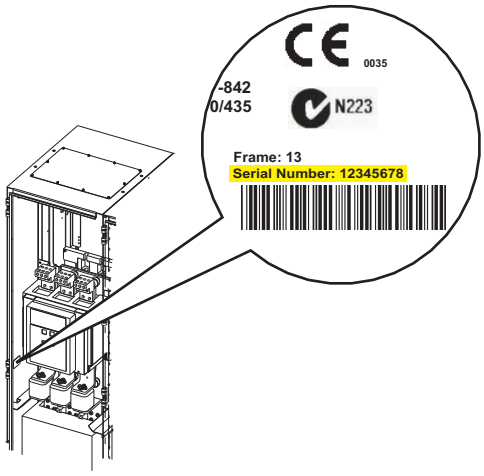
Disassembly/Assembly Diagrams and Spare Parts

Diagram	Page
AFE Power Structure Assembly External Components	D-2
AFE Power Structure Internal Components (U, V or W Phase Assembly)	D-3
AFE Power Structure ASIC Assembly	D-4
LCL Filter Assembly	D-5
LCL Filter Power Supply Assembly	D-6
LCL Filter Fan Assembly	D-6
Precharge Assembly for AFE in IP20 2500 MCC Style Enclosure	D-7
Precharge Assembly for AFE in IP21 Rittal Enclosure	D-8
AC Line Switchgear Components for AFE in IP20 2500 MCC Style Enclosure	D-9
AC Line Switchgear Components for AFE in IP21 Rittal Enclosure	D-10

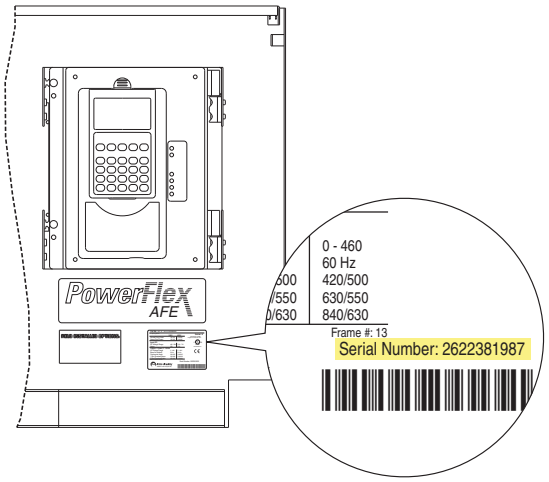
Diagrams on the following pages illustrate disassembly and assembly of the AFE and its sub-systems and are followed by a list of spare part numbers where applicable.

When ordering spare parts, you must provide the serial number of the PowerFlex Active Front End. The serial number is located on the data nameplate on the Control Frame just above the bar code.

Data Nameplate on AFE
in IP20 2500 MCC Style Enclosure



Data Nameplate on AFE
in IP21 Rittal Enclosure



A complete list of spare parts for the Frame 13 PowerFlex Active Front End is available on the Allen-Bradley website at http://www.ab.com/support/abdrives/powerflex70/PF7ReleasedParts.pdf.

AFE Power Structure Assembly

Figure D.1 AFE Power Structure Assembly External Components

ATTENTION: The sheet metal cover and mounting screws on the ASIC Board located on the power structure are energized at (-) DC bus potential high voltage. Risk of electrical shock, injury, or death exists if someone comes into contact with the assembly.

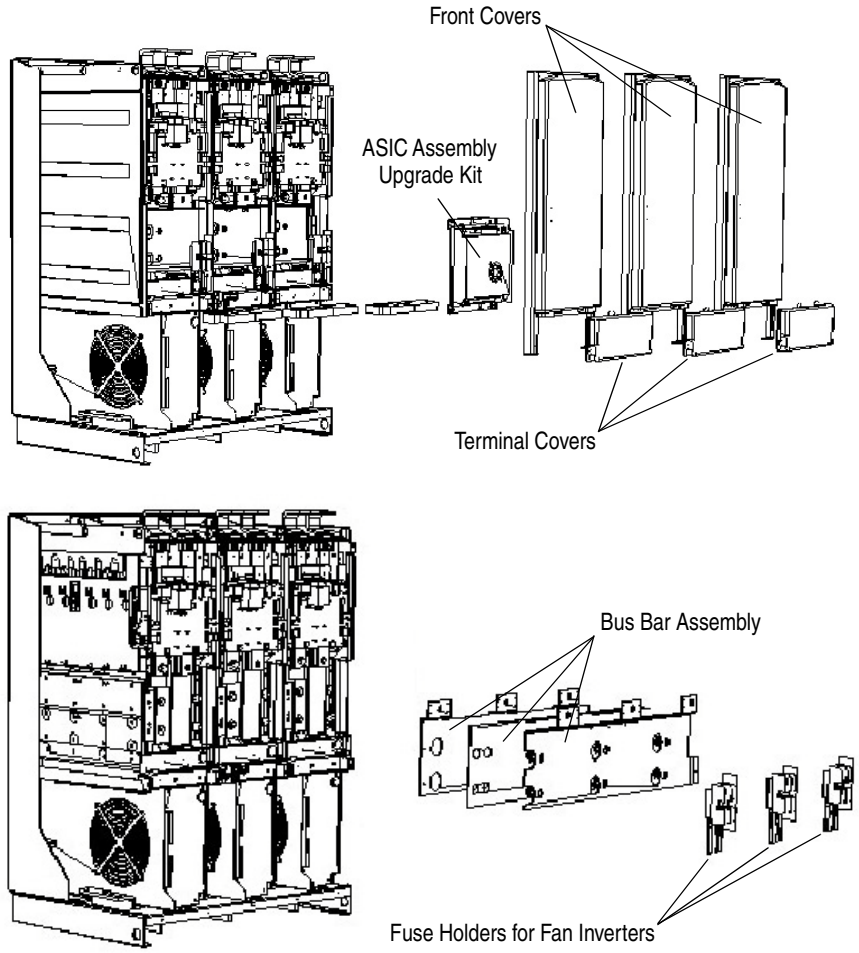


Table D.A AFE Power Structure Assembly External Component Part Numbers

Part Name		Part No.
ASIC Assembly Upgrade Kit (without ASIC Board)		20-FR10850
Bus Bar Assembly		n/a
Fuse Holders for Fan Inverters (only AC fan system)		20-PP01094 (1)
Fan Inverter Fuse (only AC fan system)		20-PP20202 (1)
Terminal Covers		n/a
Front Covers		n/a
Power Structure	400/480V (1300A)	SK-Y1-PWRMOD-D1K3
	600/690V (1030A)	SK-Y1-PWRMOD-E1K0
Maintenance Stand		20-MAINSTD

(1) For additional AC fan system information, see publication PFLEX-IN029.

Figure D.2 AFE Power Structure Internal Components (U, V or W Phase Assembly)

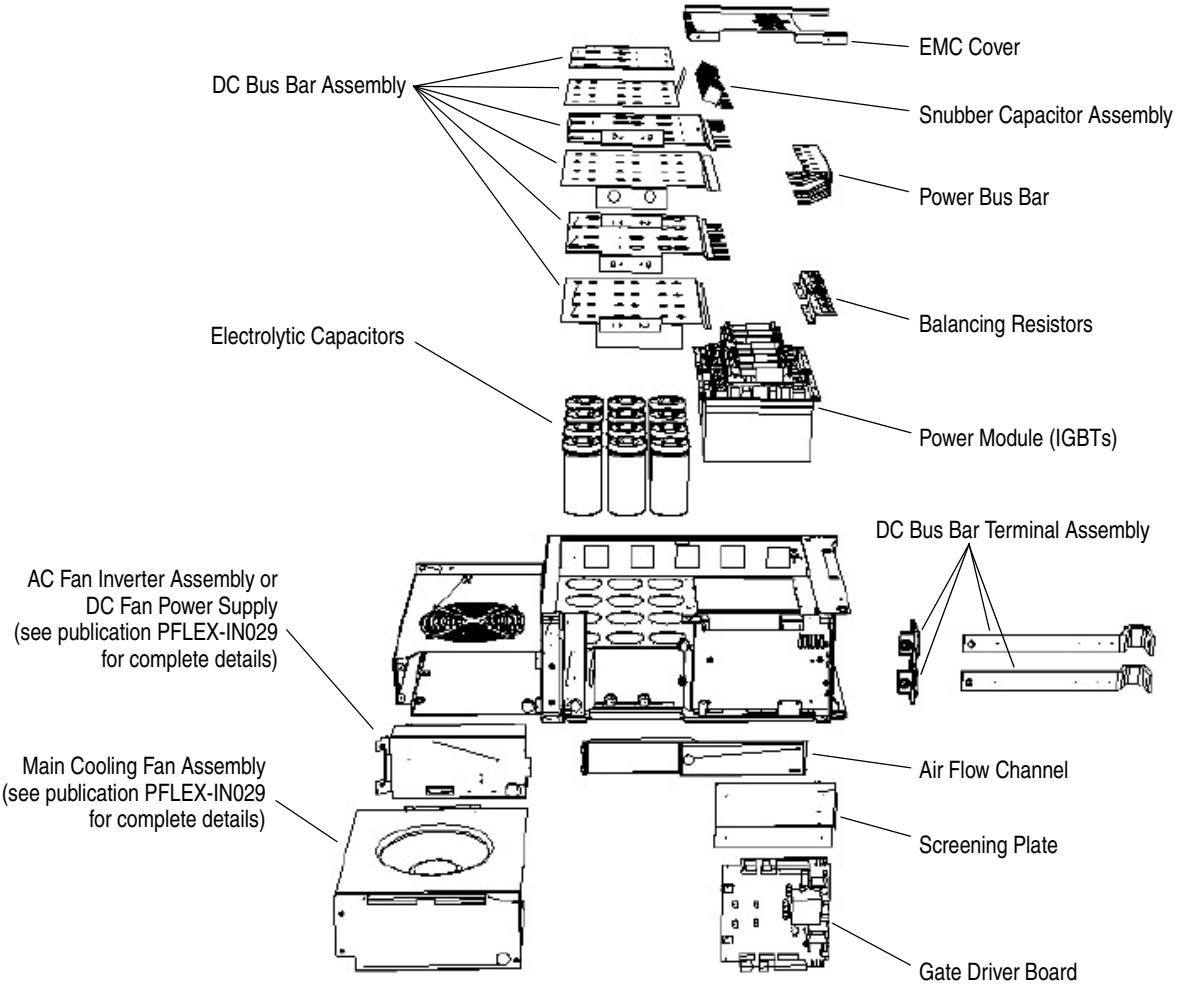


Table D.B AFE Power Structure Internal Component Part Numbers for U, V, or W Phase Assembly

Part Name		Part No.
Air Flow Channel		n/a
Balancing Resistors		n/a
DC Bus Bar Assembly		n/a
DC Bus Bar Terminal Assembly		n/a
Electrolytic Capacitors	ELKO 3300 µF 420V for 400/480V AFE	20-PP01005
	ELKO 5600 µF 420V for 600/690V AFE	20-PP01099
EMC Cover		n/a
Gate Driver Board	400/480V	SK-H1-GDB1-F1314D
	600/690V	SK-H1-GDB1-F1314E
Power Module	400/480V	SK-H1-QOUT-D1K3
	600/690V	SK-H1-QOUT-E1K0
Power Bus Bar		n/a
Screening Plate (for Gate Driver Board)		n/a
Snubber Capacitor Assembly		n/a

ATTENTION: The sheet metal cover and mounting screws on the ASIC Board located on the power structure are energized at (-) DC bus potential high voltage. Risk of electrical shock, injury, or death exists if someone comes into contact with the assembly.

Figure D.3 AFE Power Structure ASIC Assembly

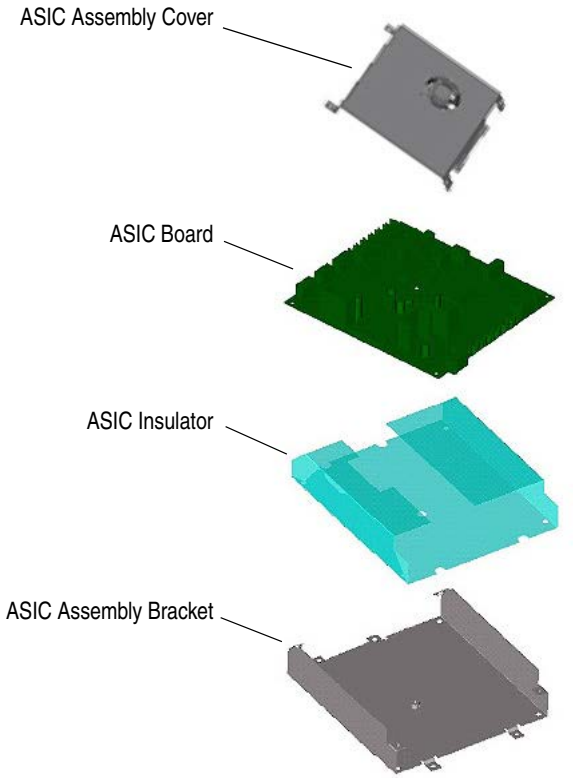


Table D.C AFE Power Structure ASIC Assembly Part Numbers

Part Name		Part No.
ASIC Assembly Bracket		Included in 20-FR10850
ASIC Assembly Cover		
ASIC Assembly Insulator		
ASIC Board (1)	400/480V AFE	SK-H1-ASICBD-D1300
	600/690V AFE	SK-H1-ASICBD-E1030
Fiber Optic Cable Set		20-PP09017

(1) The ASIC board is unprogrammed.

LCL Filter Assembly (used in IP20 and IP21 enclosures)

Figure D.4 LCL Filter Assembly

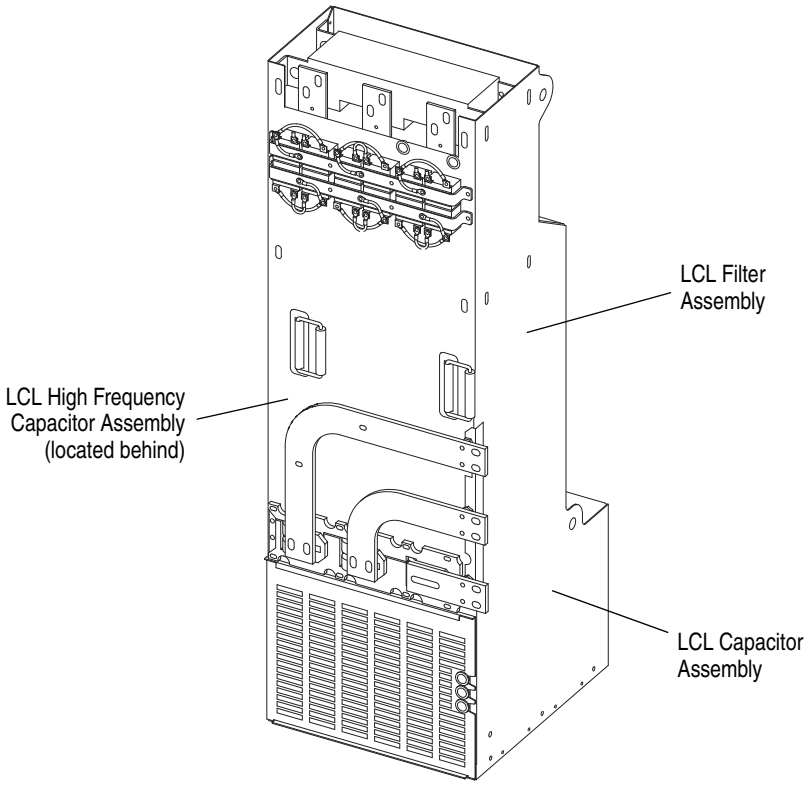


Table D.D LCL Filter Assembly Part Numbers

Part Name		Part No.
LCL Filter Assembly	400/480V	SK-Y1-LCL1-D1K3
	600/690V	SK-Y1-LCL1-E1K0
LCL High Frequency Capacitor Assembly	25 µF 400/480V	SK-Y1-CAPHF3-DF
	20 µF 600/690V	SK-Y1-CAPHF2-DF
LCL Capacitor Assembly	120 µF 400/480V	SK-Y1-CAPLCL1-D1K3
	53 µF 600/690V	SK-Y1-CAPLCL1-F1K0
LCL Filter Inverter Fan Fuse		SK-Y1-F11-F10

Figure D.5 LCL Filter Power Supply Assembly

Table D.E LCL Filter Power Supply Assembly Part Numbers

Part Name		Part No.	
		Universal Kit	Discontinued July 2014 (2)
LCL Filter Power Supply	400/480V	SK-Y1-DCPS2-F10 (1)	SK-Y1-DCPS1-D460
	600/690V		SK-Y1-DCPS1-F325
LCL Fan Wire Kit		SK-Y1-HF1-DF	

(1) This kit can be used for either voltage class.

(2) These discontinued kits are no longer available, but spares inventory is applicable.

Figure D.6 LCL Filter Fan Assembly

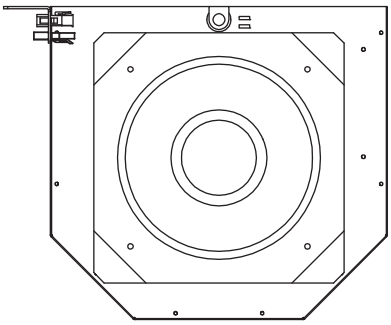


Table D.F LCL Filter Fan Assembly Part Number

Part Name	Part No.
Main Fan, 48V DC	SK-Y1-DCFAN1

Precharge Assembly

Figure D.7 Precharge Assembly for AFE in IP20 2500 MCC Style Enclosure

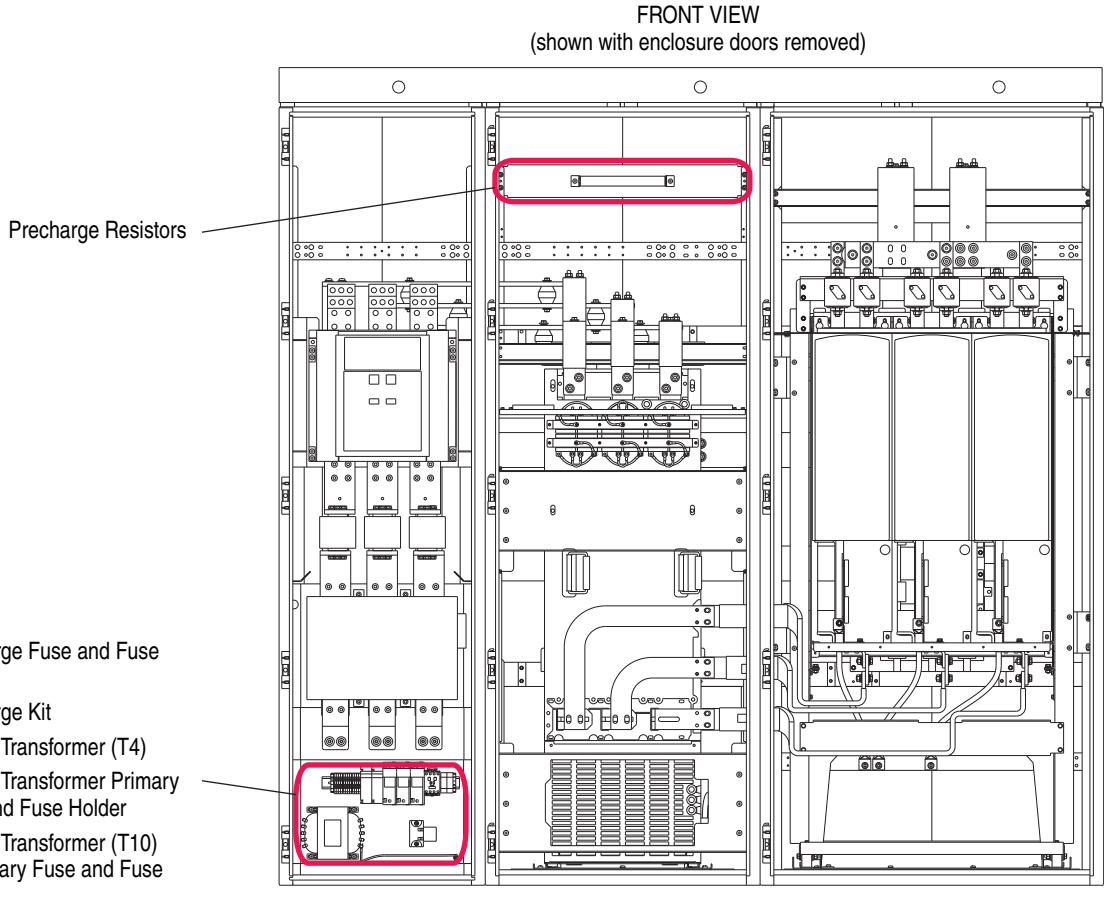

FRONT VIEW
(shown with enclosure doors removed)
Precharge Resistors
• Precharge Fuse and Fuse Holder
• Precharge Kit
• Control Transformer (T4)
• Control Transformer Primary Fuse and Fuse Holder
• Control Transformer (T10) Secondary Fuse and Fuse Holder

Table D.G Precharge Assembly Part Numbers for AFE in IP20 2500 MCC Style Enclosure

Part Name		Part No.
Precharge Fuse		SK-Y1-MCCF5-F13
Precharge Fuse Holder		SK-Y1-MCCF5FUSEHOLDER-F13
Precharge Kit (1)		SK-Y1-PRE2-F13
Control Transformer (T4), 1500VA		SK-R1-OFANXFMR-F13
Control Transformer Primary Fuse	400/480V	SK-Y1-MCCF6-D
	600/690V	SK-Y1-MCCF6-F
Control Transformer Primary Fuse Holder		SK-Y1-MCCF6FUSEHOLDER
Control Transformer (T10) Secondary Fuse/Holder		SK-Y1-MCCF3F4

(1) Kit includes diode bridge (V6), one resistor (R6.1), and a snubber capacitor (C1).

Figure D.8 Precharge Assembly for AFE in IP21 Rittal Enclosure

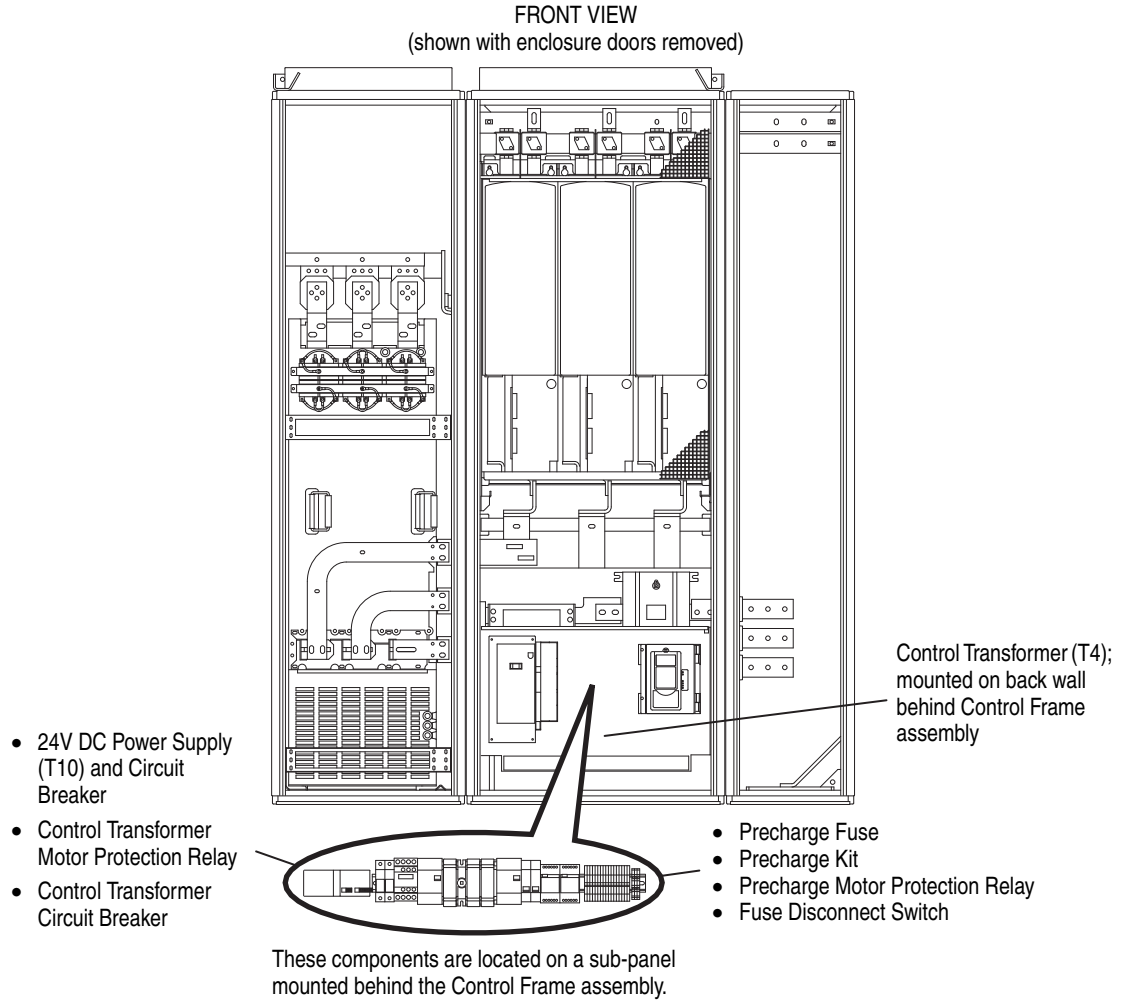

FRONT VIEW
(shown with enclosure doors removed)
Control Transformer (T4); mounted on back wall behind Control Frame assembly
• 24V DC Power Supply (T10) and Circuit Breaker
• Control Transformer Motor Protection Relay
• Control Transformer Circuit Breaker
• Precharge Fuse
• Precharge Kit
• Precharge Motor Protection Relay
• Fuse Disconnect Switch
These components are located on a sub-panel mounted behind the Control Frame assembly.

Table D.H Precharge Assembly Part Numbers for AFE in IP21 Rittal Enclosure

Part Name		Part No.
Precharge Fuse	400/480V	SK-Y1-F6-D
	600/690V	SK-Y1-F6-F
Fuse Disconnect Switch		SK-Y1-F6-DISC-DF
Precharge Kit (1)		SK-Y1-PRE1-F13DF
Control Transformer (T4), 750VA	400/480V	SK-Y1-T4-D
	600/690V	SK-Y1-T4-F
Control Transformer Motor Protection Relay		SK-Y1-Q4-DF
Control Transformer Circuit Breaker, 4A	400/480V	SK-Y1-F3-D
	600/690V	SK-Y1-F3-F
24V DC Power Supply (T10)		SK-Y1-T10-DF
24V DC Power Supply Circuit Breaker, 2A		SK-Y1-F10-DF
Precharge Motor Protection Relay		SK-Y1-Q5-F13

(1) Kit includes diode bridge (V6), contactor (K6), two resistors (R6.1 and R6.2), and a snubber capacitor (C1).

AC Line Switchgear

Figure D.9 AC Line Switchgear Components for AFE in IP20 2500 MCC Style Enclosure

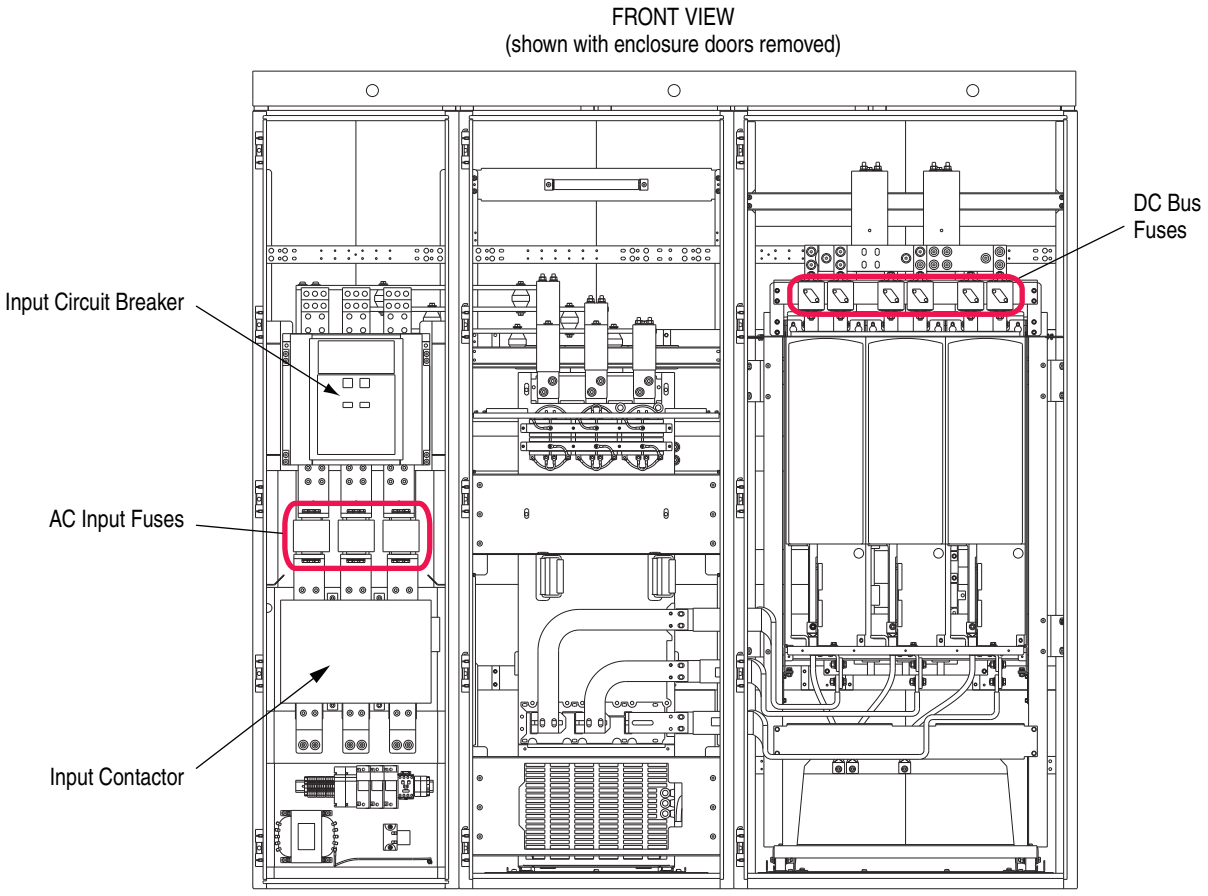


Table D.I AC Line Switchgear Part Numbers for AFE in IP20 2500 MCC Style Enclosure

Part Name		Part No.
AC Input Fuses	400/480V	SK-Y1-MCCF1-F13D
	600/690V	SK-Y1-MCCF1-F13F
DC Bus Fuses	400/480V	SK-Y1-MCCF2-D
	600/690V	SK-Y1-MCCF2-F
Input Circuit Breaker	400/480V	SK-Y1-MCCQ0-F13
	600/690V	
Input Contactor		SK-Y1-MCCK1-F13
LCL Filter Bay Door Fan Kit (two at top of door; not shown)		20-750-FAN3-F8
Right-side Bus Splice Kit (not shown; optional)		SK-Y1-BUSSPLICE-F13R
Left-side Bus Splice Kit (not shown; optional)		SK-Y1-BUSSPLICE-F13L
MCC Bus Splice Barrier Kit (not shown; optional) (1)		SK-Y1-MCCBARRIER

(1) The MCC Bus Splice Barrier kit must be used when installing a Right-side Bus Splice kit (SK-Y1-BUSSPLICE-F13R) or a Left-side Bus Splice kit (SK-Y1-BUSSPLICE-F13R).

Figure D.10 AC Line Switchgear Components for AFE in IP21 Rittal Enclosure

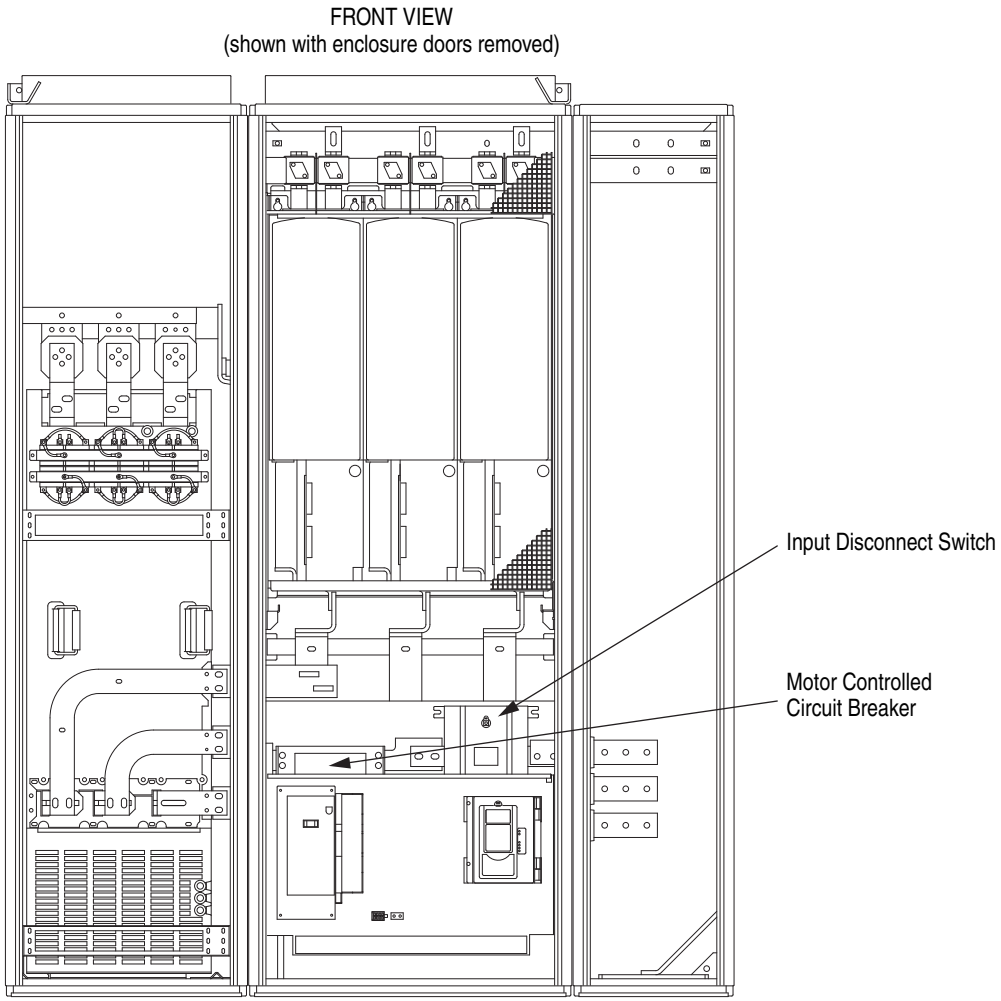


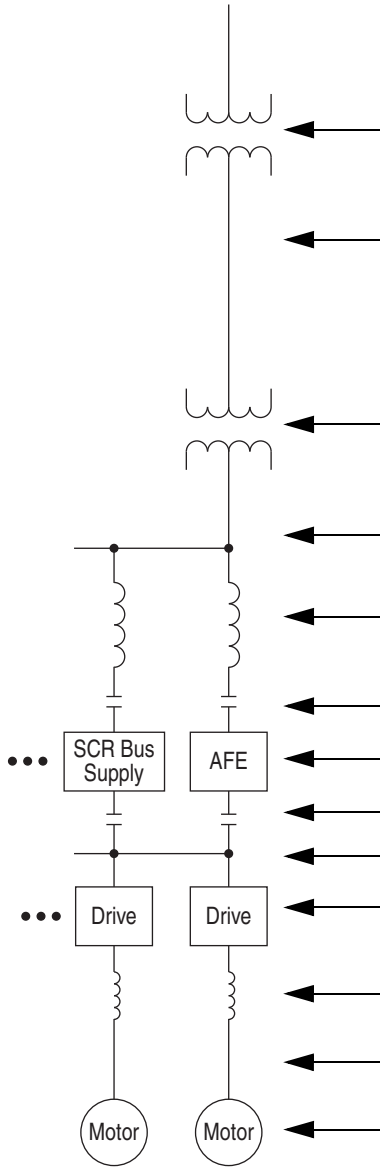
Table D.J AC Line Switchgear Part Numbers for AFE in IP21 Rittal Enclosure

Part Name		Part No.
Control Circuit Relay	230V AC	SK-Y1-K20-DF
	24V DC	SK-Y1-K4-DF
Input Disconnect Switch		SK-Y1-Q0-F13
Motor Controlled Circuit Breaker		SK-Y1-Q1-F13

AFE Power One-line System Application Data

Data to Collect

Collect the following AFE system data before contacting Allen-Bradley Technical Support.



Utility	Transformer
Type	
Input Volts	
Output Volts	
kVA	
Z	
Ground	

Delta-Delta, Delta-Wye, etc.

None, Solid, High Resistive

Cable Length: _____ Cable Type: _____

Secondary	Transformer
Type	
Input Volts	
Output Volts	
kVA	
Z	
Ground	

None, Solid, High Resistive

Cable Length: _____ Cable Type: _____

❑ Line Reactor Mfgr./Cat Num: _____ % Impedance: _____
❑ Isolation Xfmr Mfgr./Cat Num: _____ % Impedance: _____

❑ Input Contactor

AFE Cat Num: _____ SCR Cat Num: _____

❑ Output Contactor

Cable Length: _____ Cable Type: _____

Drive Cat Num: _____

❑ Output Reactor Mfgr./Cat Num: _____
❑ Terminator Mfgr./Cat Num: _____

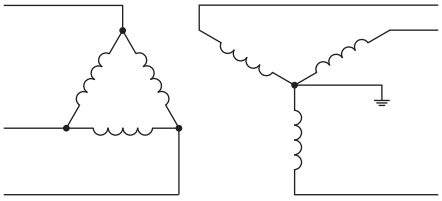
Cable Length: _____ Cable Type: _____

Motor Mfgr.	
Volts	
Amps	
RPM	
Hz	
Power	
Design No.	
Encoder	
Brake	
Motor Heater	

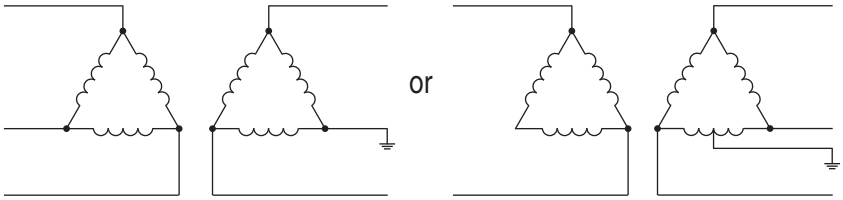
Typical Transformer Winding Types

The following diagrams show typical transformer winding types.

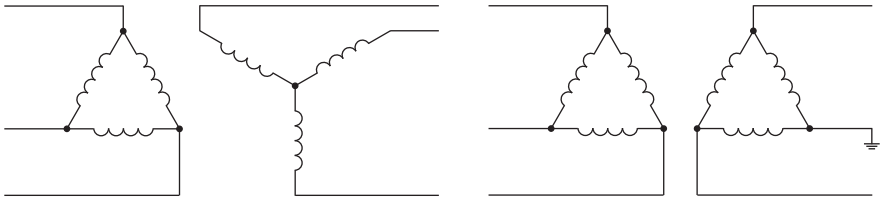
Delta-Wye with Grounded Wye Neutral



Delta-Delta with Grounded Leg
or
Four-Wire Connected Secondary Delta



Ungrounded Secondary



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Rockwell Otomasyon Ticaret A.Ş., Kar Plaza İş Merkezi E Blok Kat:6 34752 İçerenköy, İstanbul, Tel: +90 (216) 5698400

www.rockwellautomation.com

Power, Control and Information Solutions Headquarters

Americas: Rockwell Automation, 1201 South Second Street, Milwaukee, WI 53204-2496 USA, Tel: (1) 414.382.2000, Fax: (1) 414.382.4444
Europe/Middle East/Africa: Rockwell Automation NV, Pegasus Park, De Kleetlaan 12a, 1831 Diegem, Belgium, Tel: (32) 2 663 0600, Fax: (32) 2 663 0640
Asia Pacific: Rockwell Automation, Level 14, Core F, Cyberport 3, 100 Cyberport Road, Hong Kong, Tel: (852) 2887 4788, Fax: (852) 2508 1846

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